DECEMBER ISSUE ☆ ☆ ☆ 1959 NR. 4

FIGHTER WEAPONS NEWSLETTER

USAF FIGHTER WEAPONS SCHOOL

NELLIS AIR FORCE BASE • LAS VEGAS, NEVADA

FIGHTER WEAPONS

NEWSLETTER

DECEMBER ISSUE 1959 NR. 4

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ROTATIONAL INSTRUCTORS

Capt.'s William Quinn, Aubrey Edinburg, Henry Buttelmann, (not pictured) Capt. Roger Tucker.

It's Your Show

Rotational training is a comparative new comer to Nellis as an operation; however, its mission is as old as Nellis itself. Briefly its mission is threefold.

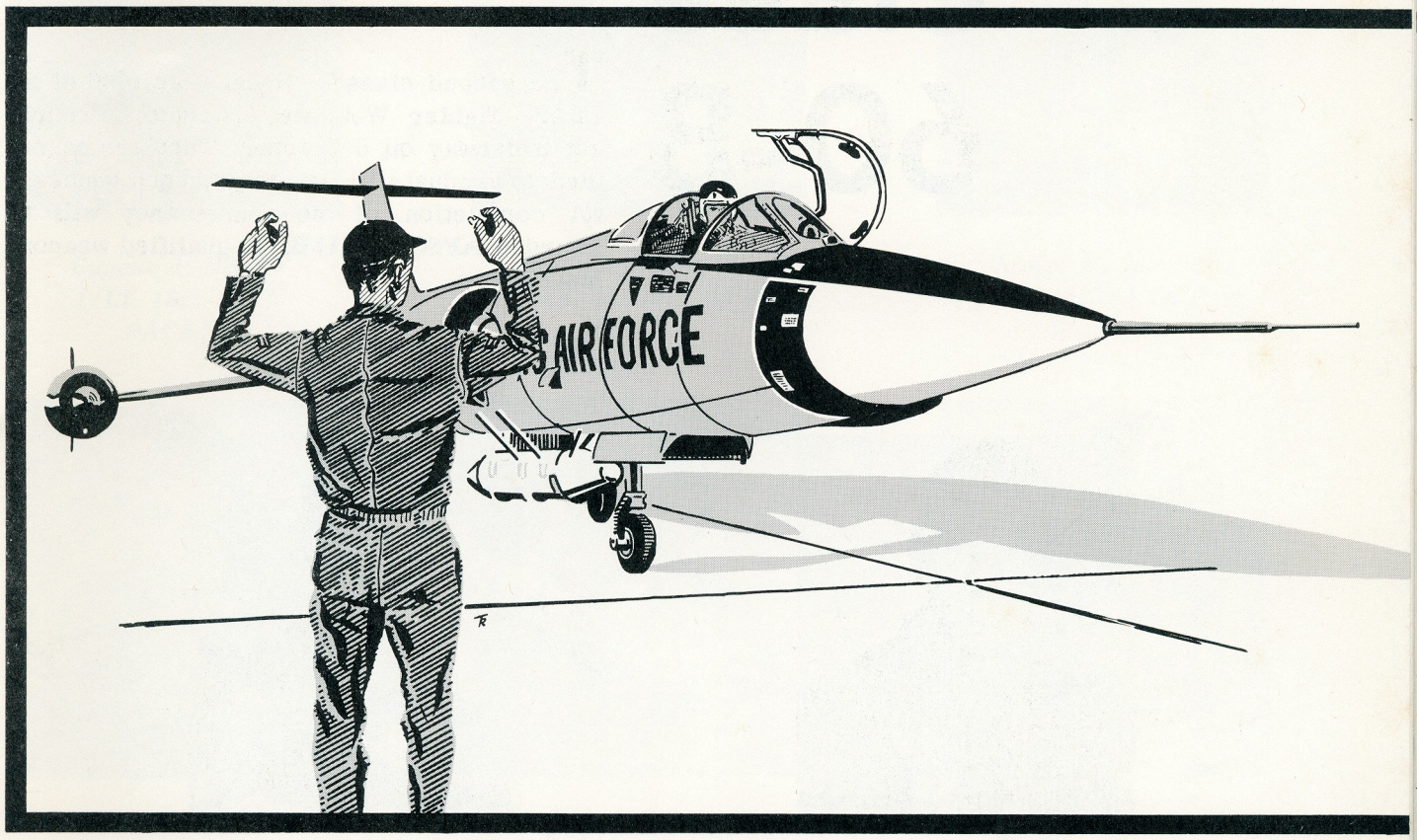
a. To provide training in the latest methods of tactical fighter weapons delivery and employment of aerial firepower to aircrews of tactical fighter units.

b. To provide academic training on fighter weapons systems and employment techniques to aircrews of tactical fighter units.

c. To provide specialized fighter weapons training as directed and required to correct unit training deficiencies. To assist in the overall operational training, instructors from the Fighter Weapons School are assigned to the operations section.

The academic schedule for rotational squadrons is prepared by the Commandant, USAF Fighter Weapons School with proportionate hours being devoted to Gar 8, Nuclear Weapons, Fire Control System, Ground Attack and Aerial Attack. The beauty of this operation, however, lies in step c of its mission. Here the tactical squadron possesses the flexibility to formulate its own flying schedule according to squadron needs. Some units have only a nuclear weapons range at their base, so their pleasure may encompass a flying schedule devoted to ground attack, aerial attack, Gar 8, and only a small portion to nuclear weapons. Where the unit has only a conventional air to ground range, emphasis would be placed on a heavy nuclear weapons schedule. Once the unit has drawn up their flying schedule, it is then coordinated with the academic schedule to assure that they coincide. Hence, a unit flying in the nuclear weapons phase would be backed up by a nuclear weapons ground school schedule. This, coupled with the excellent logistics available to the units, basically comprises the Rotational Training at Nellis. We in the Fighter Weapons School feel that this is your show and hope that we have aided you in your mission.

GENERAL INTEREST

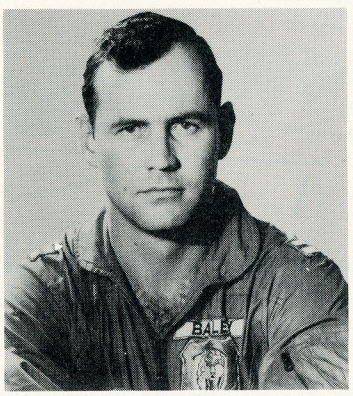


- **Class 60-B**
- **Class 60-A**
- **Low Level Mission Tool**
- **Freedom Fighter**

SECTION I

Class 60-B

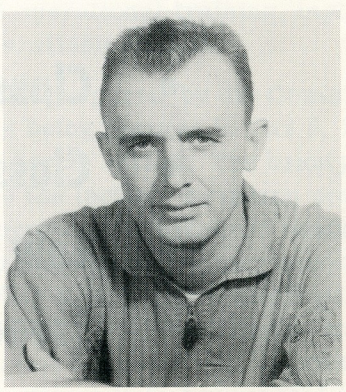
The second class of fiscal year 1960 of the USAF Fighter Weapons Instructors Course got underway on 6 October. They are scheduled to graduate 18 December. Upon successful completion of the course they will be awarded AFSC W1115B, as qualified weapons instructors.



Fred E. Bailey
Capt, 20th TFW
USAFE

Ralph L. Brooks
Capt, 31st TFW
George

William A. Bryan
Capt, 4th TFW
Seymour Johnson



Ronald E. Catton
1/Lt, 474th TFW
Cannon

Eugene J. Devlin
1/Lt, 18th TFW
PACAF

Lawrence H. Goldberg
1/Lt, 4520th CCTW
Nellis

James R. Lawver
Capt, 4533rd CCT Sq
Williams

Dennis O'Boyle
Capt, 36th TFW
USAFE

Harry E. Payne
Capt, 4th TFW
Seymour Johnson

Wycliff E. Steele Jr.
1/Lt, 405th TFW
PACAF

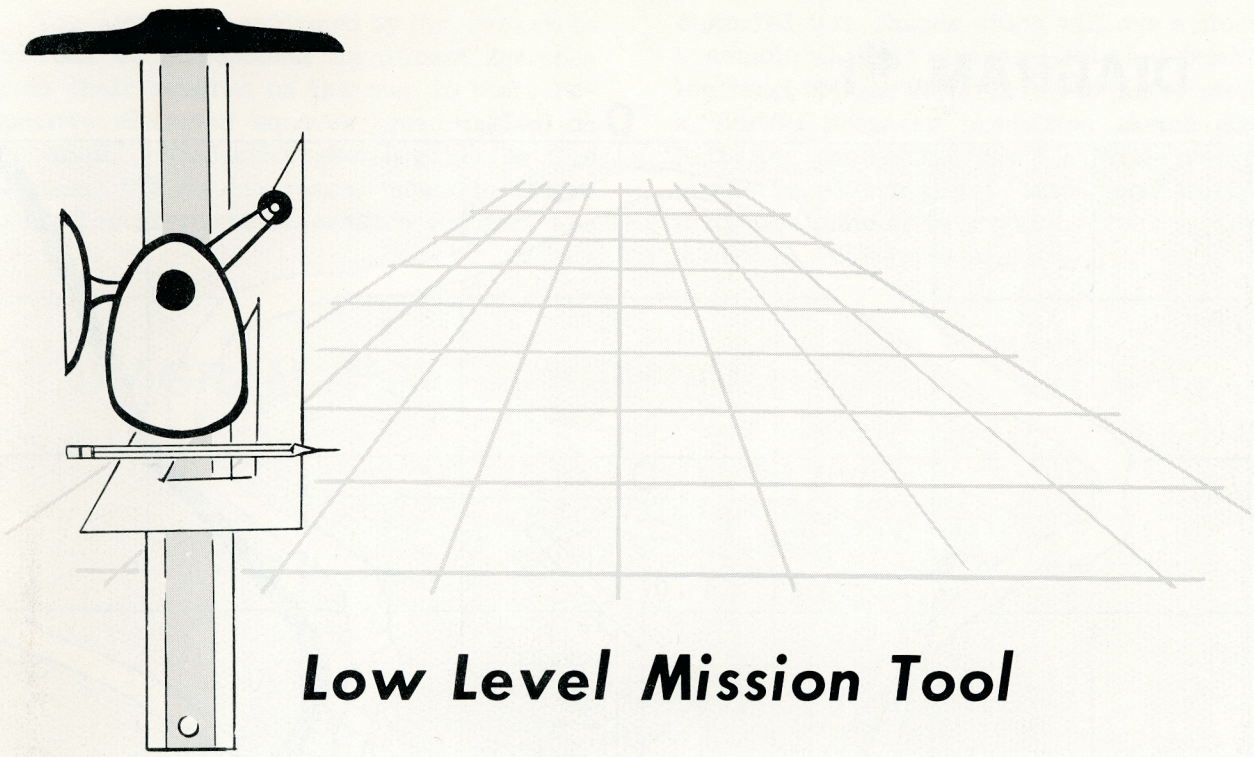
Harris J. Taylor
1/Lt, 401st TFW
England

Emeal Tipton
Capt, 4515th CCT Sq
Luke

Class 60-A

TOP GUNS

Col Ralph F. Newman, Commandant of the USAF Fighter Weapons School, presents awards to the outstanding graduates of Class 60-A. (L to R) Captain Hal W. Vincent, USMC, Academic Award; 1st Lt. Roy H. Easley, Conventional Weapons Award, 1st Lt. Lewis G. Aufdemorte, Nuclear Weapons Award.



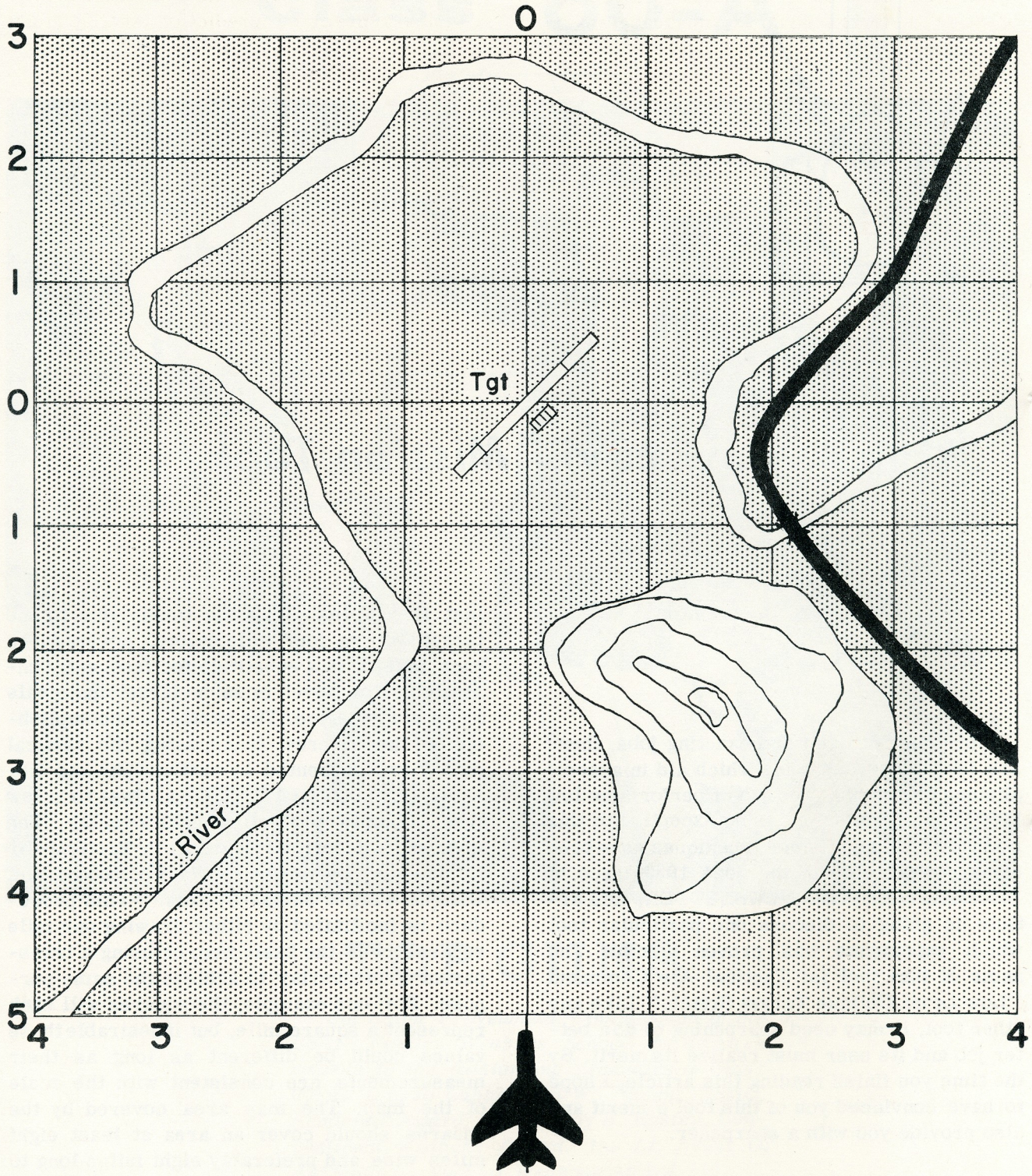
Low Level Mission Tool

By: Captain Mertes B. Boeswetter
4520th CCRTRGWG
Nellis AFB, Nev

For most difficult and exacting jobs, there are techniques and tools which aid in accomplishing the tasks. The job of performing low level bombing missions is no exception to this statement. Since mission techniques have been discussed already in the June 1959 Issue of FIGHTER WEAPONS NEWSLETTER, this article is going to discuss one particular tool which experience has proven helpful. The name of that tool is: Tactical Air Command "Low Level Oblique Target Sketch." Like any other tool, it may need sharpening to do a better job and its user must realize its merit. By the time you finish reading this article, I hope to have convinced you of this tool's merit and also provide you with a sharpener.

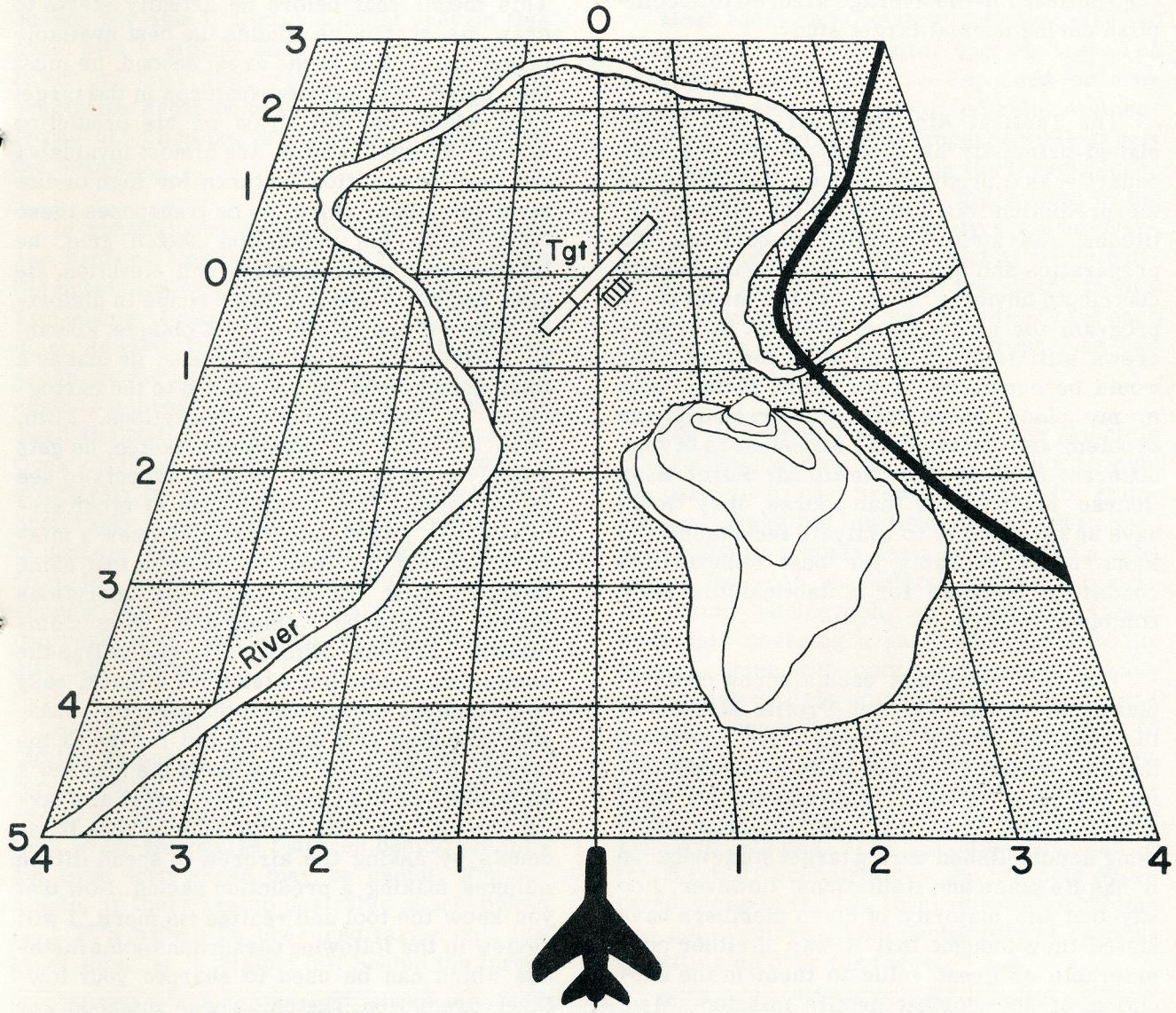
For the benefit of the unitiated, let's first describe the low level oblique target sketch. This sketch is a drawing of approximately the last five miles along the run-in line to the target with a four mile lateral coverage on each side. It is a substitute for frequently unavailable low level mission target materials and a study device. The sketch is accomplished by the aircrew transposing the vertical plan view, presented by cartography and mosaics (1:50,000 to 1:250,000 scales) to a low level oblique prediction grid overlay. The method is described in detail in Tactical Air Commands' Lectures 5 - 7 "TAC Low Level Oblique Target Sketch System." This procedure is facilitated by either drawing one mile squares over the basic map or using a transparent grid overlay to achieve the same purpose. For our example, the squares will each represent a square mile, but if desirable these values could be different as long as their measurements are consistent with the scale of the map. The map area covered by the squares should cover an area at least eight miles wide and preferably eight miles long to include an area about three miles behind the target. This step would appear as indicated in diagram #1.

DIAGRAM #1



The next step performed by the aircrew is the one of transposing significant features from their squares on the map to their respective distorted squares (quadrangles) on the actual perspective sketch grids. In this process, the rivers, roads, mountain ridges and other pertinent recognition features are distorted into shapes which will more closely resemble what the aircrew would see from his low level oblique view. This completed step on a quickly prepared prediction sketch might look like this: (diagram #2). Well-prepared prediction sketch usually takes about thirty to forty-five minutes to prepare.

DIAGRAM #2



Although the above description is a very simple one, it is indicative of the simplicity of the Tactical Air Command System. It evolved from other more accurate and complex systems requiring considerably more explanation and drawing time which limited their usability. Even the most complicated and time-consuming sketches are dependent somewhat on the native artistic talent of the sketcher in order to portray realism and a good looking sketch. These systems have been criticised for consuming too much time, requiring a complex or several grids, and being impractical for the average aircrew to accomplish during normal target study.

The Tactical Air Command sketch is designed primarily as a study device and secondarily as a predicted oblique view. Because the prediction was simulating low medium altitudes, the author initially doubted that the preparation and use of this sketch would really contribute anything of value to the target study program for a Low Level Mission. Many aircrews still feel the same way. However, they would be convinced of its value, if they were in my place where they could research the problem and examine the experiences of four different classes from Nellis Air Force Base Course 111105B. In that course, they would have an opportunity to evaluate techniques and tools under probably the best comparative conditions possible for a tactical low level bombing mission.

I do not claim that each aircrew contemplating the initial Combat Profile Mission of the 111105B Course is completely convinced that the prediction sketch is an invaluable tool for low level mission preparation. Nor am I trying to sell it as the most valuable single thing accomplished during target study because it has its place and limitations. However, I do say that the majority of class members have stated they thought that it was of either considerable or great value to them in the execution of the combat profile mission. Also, some correlation has been noted among poorly prepared prediction sketches and poor mission EWP examinations or missing the target. This and the comments of many of the class members converted the author from a skeptic to a believer in the prediction sketch. Give it a fair trial and I believe you too will join me in my conversion.

Since you cannot interview aircrews as I can, perhaps the following statements will indicate what can be achieved with the prediction sketch. First, the aircrew must closely examine the immediate target area and the terrain over which his run-in line passes. This means that before he actually starts to draw his sketch, he studies the best available target materials in the area. Second, he must then select the pertinent features in the target area which he will draw on his prediction sketch. These features are almost invariably the best recognition features for high or low level missions. Third, as he transposes these features to his prediction sketch grid, he learns their exact location and elevation. He also begins to see how their shape is distorted when viewed as a low level oblique. Fourth, he reviews the target area when he makes a final comparison of his sketch to the cartography or photographic presentations. Fifth, when he views the completed sketch, he gets a fairly good picture of what he expects to see in the area. This is also true of other aircrews who might use another aircrew's mission planning for their studying of that same mission. Last but not least, the Operations Officer, Squadron Commander, Wing Commander, Targets Officer, etc., can utilize the completed prediction sketch for a quick, easy and excellent evaluation of the aircrew's mission planning and study of his run-in to the target. If you are in doubt about the aircrew's knowledge of his run-in to the target and target areas, you can confirm or dispel those doubts by asking the aircrew to spend fifteen minutes making a prediction sketch. Now that you know the tool and realize its merit, I will review in the following paragraphs some methods which can be used to sharpen your low-level prediction sketch. These methods are not new or novel because they have been suggested or used before, but they are often neglected in mission planning and study periods.

Although most of them do not require much additional time, they might better be accomplished during the continued phases of target study where the objective is to raise the quality of mission planning and study.

One of the most obvious things which can increase the sharpness of your prediction sketch is the addition of color shading where the target area has colorful features. In so doing, the sketcher should consider the probability of vegetation changing its color during the yearly seasons. The ideal solution to this problem might be to draw a sketch for each season but time limitations might prevent this even with a simple and quick sketch system. However, once the drawer has colored the vegetation areas on his sketch, he can visualize in his mind the various color changes for the seasons.

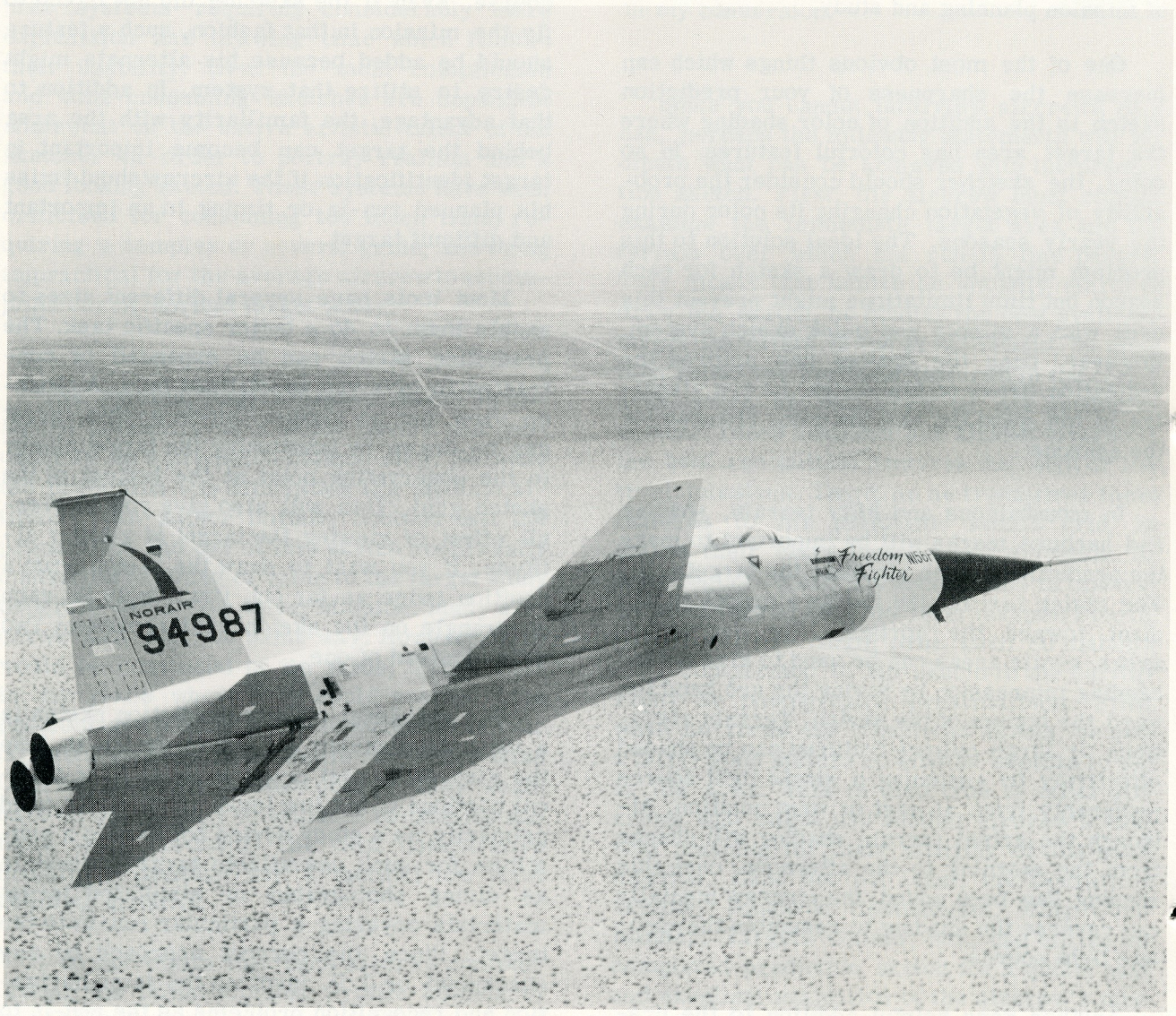
In mountainous and hilly terrain, shading and hachure marks will be important to make the prediction sketch simulate the target area. For rising terrain the hachure marks should slant toward the horizon. For depression areas, gentle areas can be used to give a descending impression by having the arc bend toward the bottom of the sketch. Terrain elevations or large culture features can be shaded effectively by assuming a single light source preferably from an east or west position. Although the actual terrain shading will change from the morning to the afternoon, once this shading has been added, the aircrew mentally can reverse the shading to resemble the opposite light source.

Another very helpful addition to the prediction sketch is the careful addition of features behind the target. Although most aircrews draw in large mountains or ridges, they tend to de-emphasize features behind the target even when these may be useful. For example, if there are no desirable check-points or I. P.'s before an obscured target on a low level mission, a visible hill behind the target might be extremely important. It could be used in the same manner that a swimmer selects a prominent object on the opposite shore to swim toward, in order to swim a straight course. Even if the sketcher did not intend to fly the mission in that fashion, such a feature should be added because his alternate might desire to utilize that system. In addition to that advantage, the familiarity with the area behind the target can become important in target identification if the aircrew should miss his planned run-in or timing to an important and difficult target.

Most tools have several different sizes to enable them to do a better specific task. The prediction sketch can be expanded or contracted to give you specialized help. A close-up view for an almost imperceptible target can be drawn by positioning the target closer to the observation point at the bottom of the sketch grid. This will also give you an overall effect of viewing the target at a lower altitude. If you want to draw the sketch from a position twice as far out, you simply let each quadrangle on the sketch grid represent two miles instead of one.

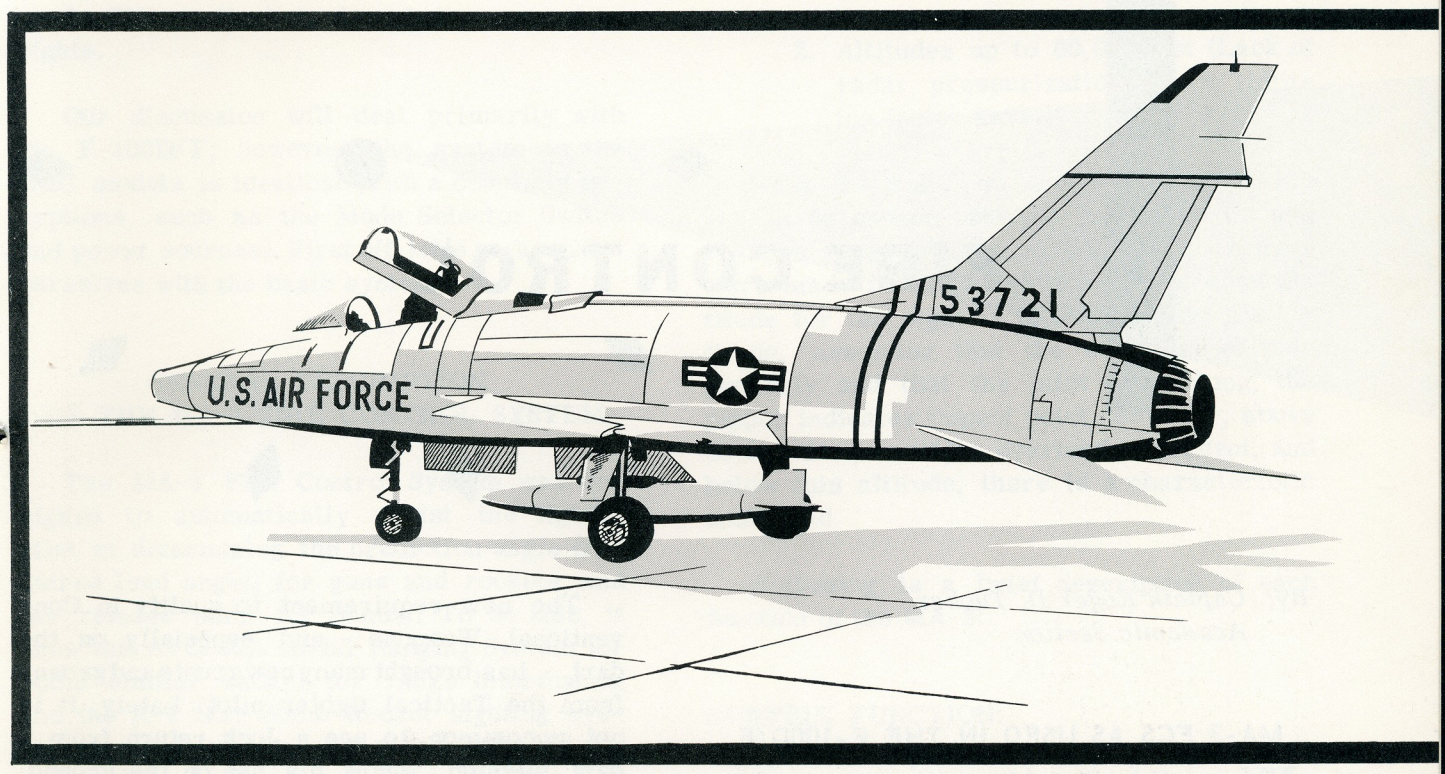
The low-level oblique prediction sketch is a valuable planning and study device to help the aircrew to best prepare himself for critical portions of his low level mission. It is used primarily as a study device but is also a substitute for such unavailable target materials as dicing photography or simulated target materials covering a particular run-in to the target. Since the correct approach to any checkpoint or I. P. involves the same navigation and recognition problems as the run-in to the target, the prediction sketch also can be applied to those critical mission areas. The sketch has proven itself to be efficatious in research studies, training situations, and in the field. Its conscientious use can help overcome some of the low level mission problems and help achieve a high probability of success in pulling up over the target.

FREEDOM FIGHTER



FIGHTER FOR ALLIES MAKES FIRST FLIGHT — Northrop Corporation's new N-156F "Freedom Fighter" is shown high over Edwards Air Force Base, California, in its first test flight. The twin-jet, multipurpose fighter is being developed under U.S. Department of Defense contract by Northrop's Norair Division at Hawthorne, California. It is the first U. S. - developed combat aircraft designed specifically for use by allied nations. Carrying bombs and advanced missiles, the N-156F is designed for attack against an aggressor's air power in the air or on the ground. The Freedom Fighter will be able to operate from short fields or to be zero-launched from concealed emplacements.

WEAPONS



- Fire Control
- Perfect Missile and Gun Attack
- Realistic Look at Harmonization
- Bomb Dispensers
- Yank and Bank
- ASG-20
- Quiz ??
- MD-6
- Bullpup Fighter Pilots Equalizer
- MK 106 Mod 0

SECTION II

FIRE CONTROL

By: Captain Roger D. Tucker
Academic Section

MA-3 FCS AS USED IN THE F-100D/F

With the advent of each new weapon - A-Bomb, H-Bomb, ICBM, etc., - newspapers, and the general public, accept it as the panacea which obsoletes all other weapons. Now, they've got us in TAC doing it! To many, the GAR-8 was the thing which made the fighter jock, with his time-honored role as a "hassler," obsolete. As a matter of fact, for the past few years there has been a running battle over the question of whether or not to remove the guns and radar from the "hundreds." Granted, the M-39's, and the MA-3 Fire Control System have severe limitations, as does the GAR-8, but in the hands of a capable tactician, who also knows his equipment, they still have a good offensive - defensive potential.

Obviously our policy-makers don't indulge in this type of "scare" thinking since TAC units are now required to qualify in the delivery of "conventional" weapons.

The new requirement to qualify in Conventional Weapons - and especially on the dart - has brought many new grunts and groans from the Tactical fighter pilot. Lately, it is not uncommon to see a Jock return from a dart mission, throw his hat on the ground, "stomp" it a few times and give out with a few choice epithets. Is poor pilot technique always the reason for reusable dart targets or is it just possible that the sight is the guilty party occasionally? Unless you know the idiosyncrasies of the fire control system, you may expect poor results despite your prowess as a "gunner."

For those of you who haven't used the sight for some time, the real objective of this article is to give you a refresher - a composite article to enable you to use the sight more effectively and detect malfunctions when they occur.

For the sake of simplicity, the following subject areas will be presented:

1. A brief description of the MA-3 Fire Control System and its capabilities.

2. Cockpit Controls, their functions and indications.

3. An analysis of sight checks.

4. Tips on the behavior of gyro computing sights.

Our discussion will deal primarily with the F-100D/F; however, the system in the A&C models is identical (with a couple of exceptions, such as the Mode Selector Switch and power sources). First off, let's re-acquaint ourselves with the basic system.

GENERAL DESCRIPTION OF THE MA-3 FIRE CONTROL SYSTEM

The MA-3 Fire Control System was designed to automatically assist the fighter pilot in determining the prediction angle (required lead angle) for guns and rockets, and the release point for bombs. To do this, it uses the APG-30A Radar Ranging System (or some similar radar) for range information and the A-4 Gun-Bomb-Rocket sighting system for computation and presentation of the required lead. This presentation is viewed on the windscreen, by the pilot, in the form of a 2 mil pipper surrounded by a ten-diamond reticle.

With both systems operating properly, the MA-3 has the capability of automatic computation within the following parameters:

Ranges:

1. Tracking Range - 600 feet to 6000 feet. (However, the range dial is unreadable beyond 4800 feet)

2. Firing Range - 700 feet to 3000 feet (The M-39 cannon is not effective beyond approximately 3000 feet)

Speeds: Up to .96 mach. (The sight is still computing above this speed, but accuracy is diminishing and an overlead characteristic exists.)

Radar:

1. Accurate within ±75 feet and will hold a lock-on with closure speeds up to 1500 knots.

2. Altitudes up to 60,000 feet (Lack of radar pressurization is the limiting factor here.)

When the MA-3 was adapted to the F-100 and M-39 cannon, several modifications and changes were required. When the changes were made it was found that the optimum altitude for the sight is 20,000 feet. At this altitude, assuming that the sight is working properly and that the pilot is tracking, the pipper indicates impact point. However, above 20,000 feet, a slight overlead is present, and below this altitude, there is a characteristic underlead.

Following is a brief description of each function of the MA-3:

GUNFIRE FUNCTION:

When using the sight in its full computing (radar ranging) function in gunfire mode, it will automatically compute the entire lead requirement in a curve of pursuit against aerial targets. It will also make a correction for airspeed and compensate for differences in air density.

If the pilot so desires, or should the radar fail, manual range information can be substituted for radar ranging by use of the throttle twist grip. Twisting the grip clockwise, just out of detent, cuts out the radar input and substitutes manual range information. With the target wingspan set into the sighthead, the pilot varies the throttle to keep the diamonds superimposed on the wing tips of the target aircraft, and, by so doing, stadiametrically determines range to the target. Realize that this will produce accurate measurement only when exact target wingspan is used and accurate spanning is accomplished from directly astern of the target.

It is quite difficult to track and manually range at the same time; therefore, accuracy usually suffers. The next best thing is pegged range. To accomplish this, determine the average range at which you plan to fire and, by use of the throttle twist grip, manually select this range. If accurate tracking is being accomplished when this range is reached, the pipper will indicate impact point. However, at longer ranges, projectiles will hit behind the pipper and at shorter ranges they will hit in front of it. Again, accuracy usually suffers because of difficulty in range estimation.

If everything else fails, don't give up yet - "Ole Emanual Caged" is still hanging around with a variable reticle diameter to assist you in lead estimation! But remember, you have the following things to consider when estimating the total amount of lead required:

Lead for target motion - determined by the formula:

$$L = \frac{V_t \times \text{SIN } \theta \times 1000}{V_P}$$

where L= lead in mils

V_t= velocity of the target in feet/second

Sin θ= Sine of the angle off

V_P= Average velocity of the projectile

Correction for gravity drop - $S = 1/2AT^2$

where S = gravity drop in feet

A = Acceleration 32.2 ft/sec

T = time of flight in seconds

Correction for trajectory shift -

$$E = \frac{Vf\ (AGF)}{Vf + Vm}$$

E = amount of trajectory shift in mils

Vf = velocity of attacking aircraft in feet/sec

Vm = muzzle velocity of the projectile

AGF = angle between the gun line and the flight path.

Using the formula:

$$\frac{\text{Wing Span (feet)}}{\text{Range Dial Reading (feet)}} = \frac{\text{Reticle Diameter (mils)}}{1000}$$

Reticle size can be determined that will allow you to use the bottom diamond as the tracking index for the required lead. However, remember that the smallest reticle diameter available is 16 mils and the largest is 150 mils.

ROCKET FIRE FUNCTION

The rocket function differs from the gun-fire function in only two respects:

1. The sight is computing for only one fixed range - 2400 feet (The radar and manual range information still goes to the sight-head to vary reticle diameter and range dial reading but is prevented from going to the gyros in the computer).

2. The variable rocket depression network (VRDU) will depress the reticle a maximum of 10° (174.5 mils). If used in full computing function, the sight will compute the lead required for moving ground targets. However, because of the "loose" reticle at longer ranges (2400 feet) and the added tracking time required (3 - 5 sec) for an accurate solution (plus increased pendulum effect caused by the depressed sight line) the sight is seldom used in full computing function.

Rather, certain firing conditions are established, the required depression computed, and the sight is used as a fixed (electrically caged) depressed sight for rockets and bombs.

BOMB FUNCTION

The bomb function was designed primarily to decrease the hazard of bombing by increasing the altitude at which pilots could bomb accurately. When the bomb function is selected, the reticle extinguishes and reappears, within about ten seconds, at a point 174.5 mils (10°) below its initial position. With the depressed sight-line, if the pipper is maintained on the target, at some point during the pass the aircraft flight path will become tangent to the bomb's trajectory. When this occurs, the aircraft will be in a positive 1/2G condition and the reticle will extinguish momentarily. This will be the proper release point for particular conditions or airspeed and altitude (the sight corrects for airspeed and head or tail wind in the bomb function). If the selector switch is in "A-4" or "Dive" position and the bomb button is depressed, the bomb should automatically release when the reticle extinguishes.

Here again, tracking difficulty is experienced because of a "loose" and greatly depressed reticle. Turbulent air can easily cause a premature release. This can be overcome by manually releasing the bomb at the instant the reticle extinguishes. Earlier swept wing aircraft experienced trouble when releasing in a 1/2G condition, because of the tendency of the bomb to float up into the flap or horizontal stabilizer. However, with forced ejection, many pilots have successfully used this function in the F-100 with good accuracy. Now, let's look at the "gadgets" in the cockpit.

COCKPIT CONTROLS AND INDICATIONS

Mode selector switch - this switch is factory-installed on F-100F and -D-90, and subsequent models, and has been depot-installed on all aircraft that have been through "King's Lift" modification. If an aircraft still has the Release Signal Switch on the control panel, the sight is turned on and off by the gun safety switch and this paragraph will be inapplicable. For modified aircraft, the following functions are pertinent:

OFF - nothing works

Sight and Radar Position - All components of the MA-3 Fire Control Systems are operating.

Manual Position - only the A-4 sighting system is operating.

If radar is desired, put the Gun-Missile Switch to the "MISSILES" position.

Dive Position - Used for automatic bombing. Same as manual.

TOSS, LABS and LABS ALT Positions - The computing sight is not used in these positions.

SIGHT SELECTOR UNIT - Gun-Bomb-Rocket Selector permits selection of the function to be used.

VARIABLE ROCKET DEPRESSION NETWORK (VRDU) depresses the reticle in rocket function.

TR-HI-LO SWITCH - This switch is a subject of much controversy and misunderstanding. The March 1957 issue of the Newsletter has a very good article, written by Captain Robert Thor, explaining the operation of this switch, so we won't discuss it in detail here. Bob says "Every-body should TR-HI-LO for himself."

Basically, the TR-HI-LO switch is a rate of roll selector. For different target-fighter speed relationships, the *rate of roll* required to track the target will vary. This affects the position of the pipper in relation to the impact point of the projectile. Since only one rate of roll can be calibrated into the gyro - and

there are many, many possible - the TR-HI-LO switch permits three selections, which are adequate for most situations. If the TR-HI-LO switch is used according to the following guide, you should receive maximum accuracy from it.

HI - use this position if G's are decreasing and/or you are rolling out of your turn in order to track the target.

TR - Use this position if G's are fairly constant and you have practically no rolling motion.

LO - Use this position if G's are increasing fairly rapidly and/or a relatively high rate of roll is required to track the target.

ELECTRICAL CAGE

The electrical caging system makes possible a stiff reticle during violent maneuvers at long ranges. Should the reticle disappear, depressing the electrical cage button will return it to the windscreen. The electrical caging system sends to the gyros, a fixed range signal of 850 feet, which overrides the range information from the radar or manual ranging. This has no effect on the range information going to the sighthead. The reticle sizing mechanism and range dial are still operative and manual and radar ranging still varies reticle size and range dial indication.

Bomb-Target Wind Scale - Adjustment for putting head or tail wind information into the computer while operating in the bomb function.

Sight Dimmer - Adjust brightness of the reticle.

Wingspan Lever - The Wingspan Lever is located on the sight head and provides a means for adjusting the reticle sizing mechanism so that target wingspan may be used as a constant in range estimation. To calibrate the manual ranging system, it is merely necessary to select the target wingspan on the 30 to 120 foot scale. Now, when the target's wing tips are spanned with the reticle, accurate range information is fed into the computer. Wingspan setting is of no importance when using radar ranging.

Mechanical Cage Lever - Putting this lever in the "cage" position inactivates the computing system and provides a fixed optical sight. Mechanically caging the sight does the following things:

1. Mechanically locks the prediction mirror and drive motors in a fixed position.

2. Drives the range dial to 600 feet.

3. Cuts off the plate voltage to the sight amplifiers.

Range Dial - Indicates range to the target.

Sight Filament Selector - Selects the desired filament of the dual - filament reticle bulb.

Min-Max-Range Sweep Control - The purpose of the min-max rheostat is to adjust the outer limit of the range within which the radar will detect and lock onto a target. Selection of the "min" position restricts the maximum range at which a lock-on can be accomplished (approximately 5,000 feet) while the "max" position allows lock-on's out to ranges of 9,000 to 10,000 feet.

Target Selector Button (Radar Reject Button) - This control is located on the stick and allows the pilot to reject unwanted targets. Pressing the button firmly should cause the radar to break lock and search for another target. Some radars will not easily break lock from a strong target, so it may be necessary to press the button several times.

This button, through a relay in the radar set, also gives a quick return to gunfire function when operating in the rocket or bomb modes.

Indications of a Radar Lock-On - The following are cockpit indications of radar lock-on:

Illumination of the lock-on light on the sight head.

The range dial reads range to the target.

Reticle size varies with range to the target.

Increased brightness of the sight reticle. (In the "F" D-90, and aircraft modified in T.O.). Now that we've had a rehash of general operation, cockpit controls and indications, lets investigate the symptoms of a properly functioning sight.

SIGHT CHECKS

The ability to make a proper sight check to determine how well the sight is working, is something that should appeal to every fighter pilot. The most immediate gain which you may expect as a result of acquiring this ability, is "higher scores." Naturally, the more familiar you are with the equipment and its proper use, the better you can employ it in doing a job. If every pilot in the outfit makes a good sight check each mission and makes clear and informative write-ups, you can expect more dependable and usable sights. This, again, will increase your scores and overall effectiveness.

To make sight checks more meaningful, we will first state the check, tell what we are checking for, then analyze the possible indications.

GROUND SIGHT CHECKS

1. Check Form 781	1. Note any sight write ups that may limit the mission to be flown.
2. Mode Selector switch to "Sight and Radar" or gun safety switch to "Sight, Radar and Camera."	2. Do this after all generators are operating on the line.
3. Check for reticle	3. If no reticle appears, check: a. Mechanical cage lever "caged" b. Reticle dimmer switch to full bright c. Check both primary and secondary filaments.
4. Reticle centered on the windscreen	4. Indicates that the mechanical locks are holding. If the reticle is not centered, the locking mechanism may be bent and mechanical caged harmonization will have been spoiled.
5. Range Dial Reads 600 ft.	

6. Warm up time	6. From the time external D.C. electrical power is applied, a maximum of 15 minutes will be required for the damper fluid in the computer to become heated to operating temperature. Once the sight is turned on, 2 - 3 minutes will be required for the amplifiers to warm up and 3 - 5 minutes for the radar to time in. Should the sight be uncaged before the amplifiers are warmed up, the reticle will drift off the windscreen.
7. Move wingspan lever	7. Reticle should increase in size with increase in wingspan setting and should become smaller as wingspan is decreased.
8. Manually uncage sight	8. Reticle should center in the wingscreen and range dial should read rest range (assume no radar lock on).
9. Rest Range	9. While the radar is searching for a target, components of the sight are allowed to rest to avoid wear from continuous operation. This rest range may be 1150 feet ± 150 feet or 2850 feet ± 150 feet for the APG-30A radar, and 2400 feet or 3000 feet for the ASG-17 radar (F's and D-90 A/C as above).
10. Check Manual Ranging	10. Rotating the throttle twist grip should vary range dial and reticle size. There should be a span of 1400 feet from just out of detent to the full clockwise position. The Fighter Weapons School uses 2400 feet - just out of detent, and 1000 feet full clockwise. The manual range adjustment rhoestats are located just aft of the throttle.
11. Check Electrical Cage	11. Manually range to approximately 2400 feet and depress the electrical cage button. Pipper should rise slightly. This is due to the decrease in gravity drop correction for the shorter range (2400 feet to 850 feet).
12. Rocket Function	12. With the sight selector in "rockets", increasing the VRDU setting (clockwise) should depress the reticle, while decreasing it should elevate the reticle. Depress-

ing the electrical cage button should cause the pipper to rise approximately 4 mils. The sight is computing for 2400 feet of range in the rocket function and 850 feet when electrically caged. The difference in the gravity drop correction from 2400 feet to 850 feet is approximately 4 mils.

13. VRDU Harmonization

13. Set VRDU to the harmonized zero-mils position. Hold electrical cage and depress the target selector button. The sight should return to the gun function and the pipper should remain on the same spot as the O-mil rocket pipper. The depression read on the VRDU (Assuming that the VRDU is harmonized on zero mils) is the depression from the electrical cage pipper position to the rocket pipper position with the electrical cage button held depressed. If the electrical cage button is released, the pipper will drop an additional four mils (increased gravity drop).

14. Electrical Cage - Mechanical Cage Harmonization

14. Hold the electrical cage button and mechanically cage the sight. Pipper positions should be identical. Note: The electrical caged pipper, the mechanical caged pipper and the rocket electrical caged pipper (harmonized zero-mils position) are harmonized on the same position.

15. Sometime during the sight checks, with the wingspan set on 38 feet, take pictures of the reticle at 1,000 feet, 1,500 feet, 2,000 feet, 2,400 feet and 600 feet for film assessing purposes.

16. Write up any discrepancies noted.

AIRBORNE SIGHT CHECKS

When airborne, and with no target in the radar cone, uncage the sight.

1. Reticle should center in the windscreen.

2. Range dial should read radar rest range.

2. Indicates that radar is searching

3. Lock-on light out

3. If the light should be on, it indicates that the radar is locked onto moisture in the air, noise in the set itself or that the radar sensitivity is set too high. If the light is blinking, it indicates that the radar is locking on and breaking lock rapidly.

4. Manually select 1000 feet and porpoise the aircraft.

4. Note the amount of reticle displacement.

5. Manually select 2400 feet and porpoise the aircraft. Try to use the same amount of aircraft motion as in step 4.

5. There should be more apparent reticle movement at 2400 feet than there was at 1000 feet. This indicates that the range input to the elevation gyro, within the computer, is varying commensurately with range and that the sight is computing properly in elevation.

6. Repeat steps four and five, this time yawing the A/C.

6. Again this differential in displacement indicates that range information to the deflection gyro is varying with range, and that the sight is computing properly in deflection. Should either gyro fail to check out properly, the computing sight will not be accurate.

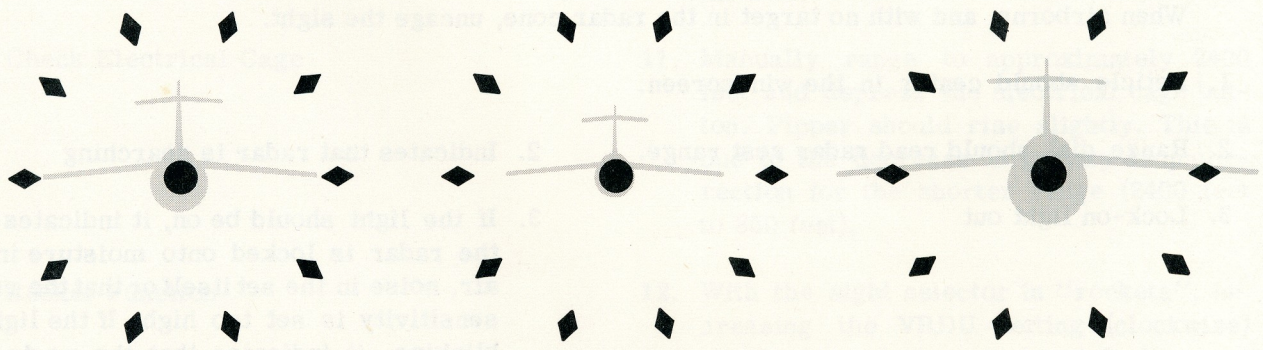
7. Radar calibration check - slide in trail, at a range of less than 2,000 feet and greater than 1000 feet (radar will not lock on at ranges less than approximately 1000 feet and reticle is too small beyond 2,300 feet). With a radar lock-on, the diamonds should span the wing tips of the target aircraft. (Wingspan lever set on targets wingspan) If not, radar range calibration is probably off.

For an approximation of the amount, manually range until the diamonds span the target's wing tips, read the range dial, release to radar ranging and note any change in range dial reading. The difference is an approximation of the range error. Note: You must be dead-astern, with no closure rate, for this check to be accurate.

Each 100 feet of range error will cause a miss distance, on the target, of approximately 6 to 8 feet.

The following illustrations show the radar sight pictures which you may get:

8. Break-lock range - apply power and close on the target aircraft. Reticle should smoothly and slowly increase in size and should continue to bracket the wing tips. The range dial should smoothly decrease in range indication. The radar should



CORRECT UNDERLEADING OVERLEADING

break lock at a range of less than 900 feet. Anything less than 900 feet is acceptable. The range dial will return to rest range and the lock-on lite will go out unless another target is within the 18 degree radar cone.

Should the range dial go to 600 feet - 800 feet and the lock-on lite remain on, there is probably an internal lock at this range. Normally, you will be able to reject this and use the full computing sight. However, every time you break off the target, at short range, it will probably be necessary to reject the internal lock-on.

That's about "it" for sight checks.

Remember - *Perform them thoroughly and make good, informative, write-ups.* If you don't know how to write up a malfunction, describe what the sight did abnormally under given conditions.

TIPS ON THE BEHAVIOR OF GYRO COMPUTING SIGHTS

A good way to become familiar with the responses of the gunsight is to maneuver the aircraft and watch the action of the reticle. A few examples: With the sight electrically caged, establish a constant-rate turn. Uncage the sight and note the transition. Holding this turn, manually change the range indication and note the effect of range on the magnitude of the lead angle. Now, hold the range constant, vary the turn rate, and observe the changes in lead. Try various maneuvers at different ranges and observe sight response. Also, while in a constant rate turn and/or while rolling, reposition the TR-HI-LO switch and note its effect on the lead angle.

With gyro computing gunsights (fighter-type aircraft) the reticle always lags aircraft motion. Therefore, when large corrections are to be made, always correct only about 2/3's of the distance and allow the reticle to drift the remaining distance. Once the pipper is on the aiming point, you must tract (hold the pipper steady) for approximately 2/3's the time of flight of the projectile before the sight will have generated an accurate solution. This means that, under normal conditions, you should have to track no more than one second before firing.

Probably the most important thing to remember is that, although this is an automatic computing fire control system, it is slightly stupid. It can comprehend only the information which you, the pilot, give it. Once it has this information, it requires time to digest the information and adapt itself to new situations - the more drastic the change, the larger the time required for the dust to settle.

So remember, if you really want to get the most out of your sight, become familiar with its operation and how it responds to different situations. Learn how to run a thorough sight check; fly a harmonized aircraft and assess film religiously! Treat the sight as a friend, and, when on a firing pass, fly in a smooth and coordinated manner and allow the sight enough tracking time to give you an accurate solution. And, if possible, learn to do these things naturally.

If you are having trouble seeing the reticle when engaging in low-angle strafing, try firing with the mode selector switch in the "toss" position. This automatically gives a bright reticle. It also gives a stiff reticle, so if you get tired of holding the electrical cage button, when using the rocket function for bombs or rockets, use the "toss" position and put the M-1 switch (M-1 control box) to the "D" position. Remember to leave the M-1 system "caged."

If you follow these few tips I'm quite sure you will receive the greatest benefit from your MA-3 Fire Control System and increase your effectiveness as the world's greatest fighter pilot.

For more detailed information on the MA-3 F.C.S., consult the Fire Control Section of the TO 1F-100D or F-2-9. ◄

THE PERFECT MISSILE AND GUN ATTACK

By: Captain Hal Vincent USMC
UMF 334 MCAF, El Toro, Class 60-A

Before World War II, the relative speed increase per year, in military aircraft development, was on the order of 16 knots per year. With the emphasis on airplanes in World War II, the rate of speed increase stepped up to 25 knots per year. During the past eight years, with the advancement of the turbojet, afterburner thrust and a reduction in the transonic drag rise, we have been advancing at the rate of over 100 knots per year. We are rapidly reaching the point where aerodynamic heating is a big problem. The temperature generated at speeds of Mach 2, and above, will hold us rather close to this figure until better materials, higher altitudes or pre-compressor cooling is obtainable. Yet, with each new increase in thrust, we increase our basic thrust-to-weight ratio and are able to climb closer to the vertical. In fact, in more than one of the present century series, it is possible to climb at a respectable angle near Mach 2, and at a very steep angle near Mach 1.

It thus becomes necessary to re-evaluate the situation in order to determine the correct gun and missile attack when it is no longer "smart money" to try to get the highest possible altitude from which to make an effective attack. Rather, with the afterburner and missile capability, a completely new attack is possible - and desirable!

It is quite apparent that any airplane with a high wing loading (i.e., high aircraft weight and small wing area) such as the later century series and the Marine F8U, can't pull many g's subsonically. However, supersonically, both airplanes can pull limit load factor, as can any plane, except as limited by the

effectiveness of the elevator, and possible pitch-up characteristics. Of course, because of fuel consumption both of these high performance airplanes must cruise subsonically until taking a bounce or trying to escape one. Since this is true, let's put the information to use!

By use of the Vn diagram (airspeed/g diagram found in every handbook) of any airplane, it is possible to determine the proper airspeed for making a perfect missile-gun attack. To show what is meant, let's take an example using a hypothetical fighter and the F-100. The Vn diagram for the hypothetical fighter, at 35,000 feet, is presented in Figure 1.

Notice that, at the subsonic cruising Mach number of .9, (516 KTAS) it is possible to pull 2.5 g initially in a maximum effort hard turn (Point A). Now, let's assume that the "Century" has the same Vn diagram. Notice that, at any supersonic speed, it is possible to pull limit load factor (Point B).

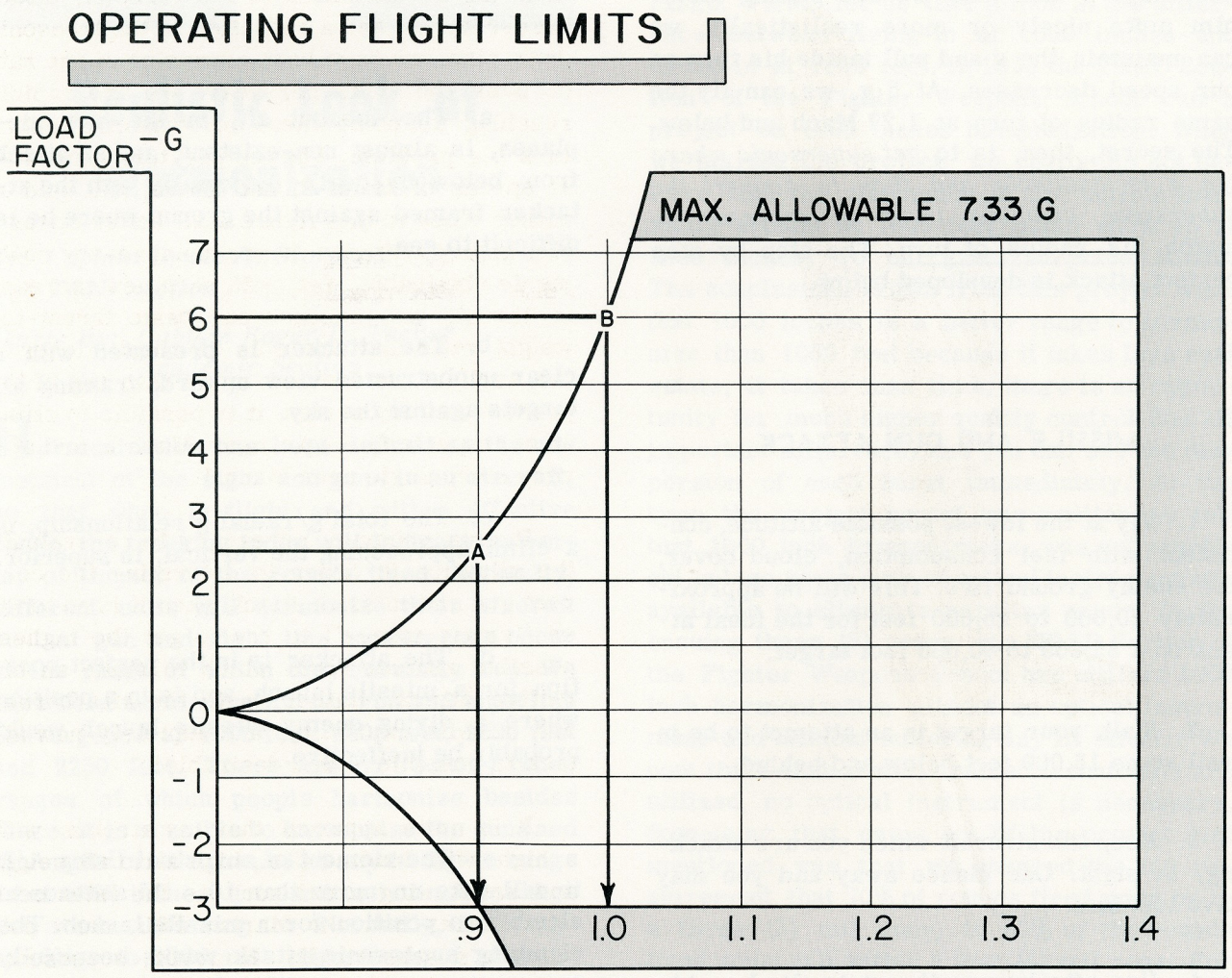


Figure 1

Using the Radius-of-turn formula to find the initial subsonic turn required of the hypothetical fighter, we find:

$$\text{Rad/turn} = \frac{.0887\ (V)^2}{g} \text{ or}$$

$$R/T = \frac{.0887\ (6576)^2}{2.5} = 8600 \text{ ft.}$$

Now is is necessary to find a supersonic speed range where it is possible to fly this same radius of turn. By equating the necessary radius of turn (9440 feet) we can determine what speed we need to fly to match it. If we are willing to pull 4 g, supersonically, we need 1.14 Mach at 35,000 feet. If we use more g than this, we are pulling inside him quite nicely or more realistically, we can maintain the g and pull inside his turn as our speed decreases. At 5 g, we can fly the same radius of turn at 1.27 Mach and below. The secret, then, is to *get supersonic where the g is available and then to convert the supersonic airspeed to g as necessary to* match his radius of turn. The step-by-step perfect attack is developed below.

MISSILE AND GUN ATTACK

1. Fly at the lowest possible altitude, consistent with fuel consumption, cloud cover, and enemy ground fire. This will be approximately 20,000 to 25,000 feet for the ideal attack on a 35,000 to 40,000 foot target.

2. Stalk your target in an attempt to be in trail some 15,000 feet below and behind.

3. Keep the aircraft which you are attacking, in sight. One glance away and you may have lost him.

4. Use afterburner thrust to climb up his tail in a supersonic high-angle climb.

5. Fire your missile when in range. If no missile is available, continue to close at a supersonic Mach of approximately 1.2.

6. If still undetected when approaching firing range, decrease Mach slightly. If you are detected when approaching firing range, and the target performs his maximum effort subsonic turn, convert the Mach to g until you are able to track.

7. If you have misjudged and are unable to track, continue the climb to near vertical, do a roll-off opposite to the direction of the enemy break, and dive in for another attack.

The advantages of such an attack are numerous:

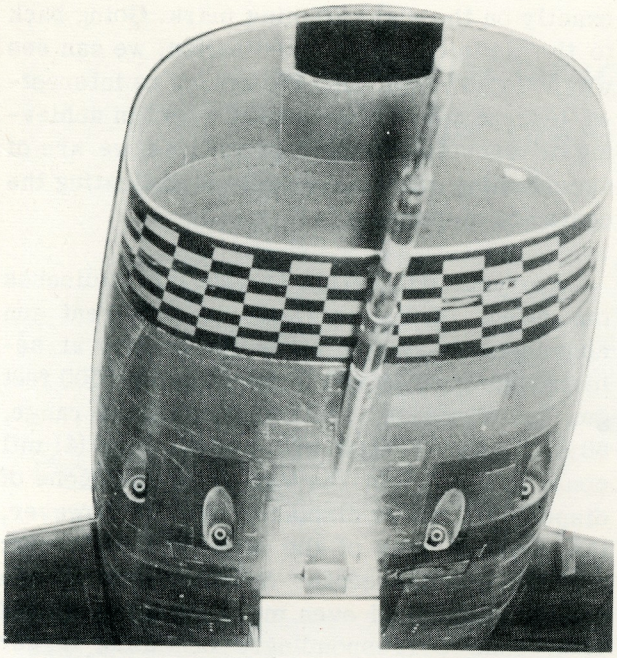
a. The lookout aft, in the new airplanes, is almost non-existent, and an attack from below is ideal - especially with the attacker framed against the ground where he is difficult to see.

b. The attacker is presented with a clear unobstructed view upward, framing all targets against the sky.

c. The total g/radial g relationship, in a climb approaching the vertical, is superior.

d. The attacker is in the perfect position for a missile launch, and is in a position where a diving enemy missile launch would probably be ineffective.

e. The element of surprise! Using A/B it will take no more than 10 - 15 seconds to climb into position for a missile launch. The climbing supersonic attack works beautifully in practice and you will seldom be detected. TRY IT. . . . . ►



Realistic Look at Harmonization

By: Captain Bruno A. Giordano
TR&D Section

Charts By: Captain Roger D. Tucker
Academic Section

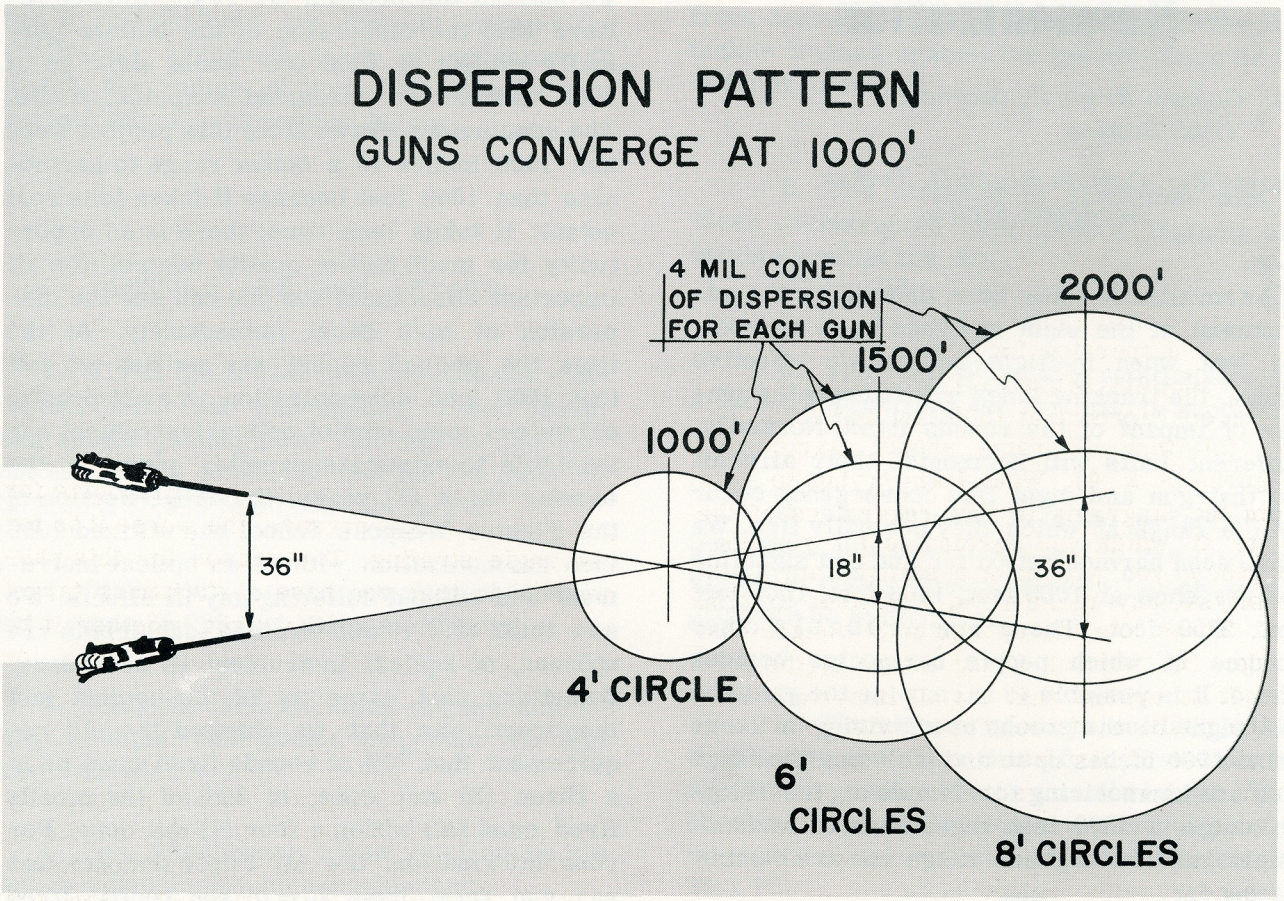
Harmonization has been defined as the adjustment of the sight and guns in an aircraft, so that when in-flight and within effective range, the tracking index will indicate the center of impact of the rounds fired. Normally, different units will harmonize their aircraft so that gun and sight line convergence occur at the range at which they normally fire. We have seen harmonization for gun and sight line convergence at 1000 feet, 1400 feet, 1600 feet and 2250 feet. There are probably other ranges at which people harmonize besides these. It is possible to harmonize the guns and the sight on the ground at any firing-in range from 1000 inches up to and including the range you are harmonizing for. Normally, the firing-in range is 1000 feet regardless of what in-flight gun convergence range you are harmonizing for.

In this article I will try to show the effect the different harmonization ranges have on your air to air firing and your low angle strafing. I also hope that I will be able to demonstrate that whether you are harmonized for 1000 feet gun and sight convergence or 2250 feet gun and sight convergence, or some range in between, the difference in impact when firing at a selected range is very small. What I am saying is that it really does not make any difference at what range you harmonize for as long as you know what to expect under different firing conditions. There is a crying need in the Air Force, especially in the tactical fighter business, for rigid standardization. Because of this and due to the small differences in impact when harmonizing for different ranges, all units should harmonize for one range. First, let us take a look at the difference between firing-in at 1000 inches and firing-in at 1000 feet. In 1956 the TR&D Section of the Fighter Weapons School ran a project on 1000 inches harmonization. When we started the project, we really did not believe that the dispersion of the bullets normally evident at 1000 feet would show up at 1000 inches. To our great surprise, it did. The conclusions drawn from this project were that 1000 inches is a better range to harmonize than 1000 feet because it takes less real estate; it takes less time; there is an opportunity for much higher quality control (the all important difference) and you can see the dispersion of each burst immediately. At the time the project report was written we felt that 1000 inch harmonization was not practical unless some sort of optical instrument was available to eliminate parallax error. In the ensuing three (3) years, the TR&D Section of the Fighter Weapons School has utilized 1000 inch harmonization without an optical instrument and without suffering any ill effects. We now think that if well-trained technicians are utilized, no optical instrument is necessary. Something that came out of the project just mentioned was that we changed the old requirement that 70% of rounds fired must be in a three (3) mil cone, to 80% of the rounds fired must fall within a four (4) mil cone. For your information, the Air Force decrees that any gun must have 75% of the rounds fired

impact in a four (4) mil cone and 100% of the rounds fired impact in an eight (8) mil cone. If your guns have done a lot of firing, you will find it difficult to obtain even so low a standard as 80% in a four (4) mil cone. This is due to poor mounts, ineffective barrel stabilization, wear on barrels and wear on general gun installation. We still feel that a ten (10) round burst is best to most economically illustrate gun dispersion. Just for fun, the next time you are out on a harmonization range and you achieve eight (8) out of ten (10) in a four (4) mil cone, load ten (10) more rounds in the same gun without changing anything and fire the belt. Dollars to donuts says that you will not achieve eight (8) out of ten (10) with this second belt. What you should be most interested in when harmonizing is that the center of dispersion of the rounds fired is in the center of the bullseye, and that the pipper is placed exactly on the sight aligning mark. Going back to the definition of harmonization, we can see why it is so important. We are not as interested (except for gunnery meet work) in achieving a very tight bullet pattern as we are of ascertaining that the pipper is indicating the center of dispersion.

For your edification I would like to discuss the effect of harmonizing for different gun convergence ranges on bullet density at selected ranges. If you harmonize for 1000 feet gun convergence, at 1000 feet actual range, 80% of rounds fired will be in a four (4) mil cone; at 1500 feet the center of each cone of dispersion will be displaced slightly; however, the physical size of the cone will be larger; at 2000 feet the center of dispersion of each cone is displaced even more, with the size of each cone correspondingly becoming larger

Figure 1



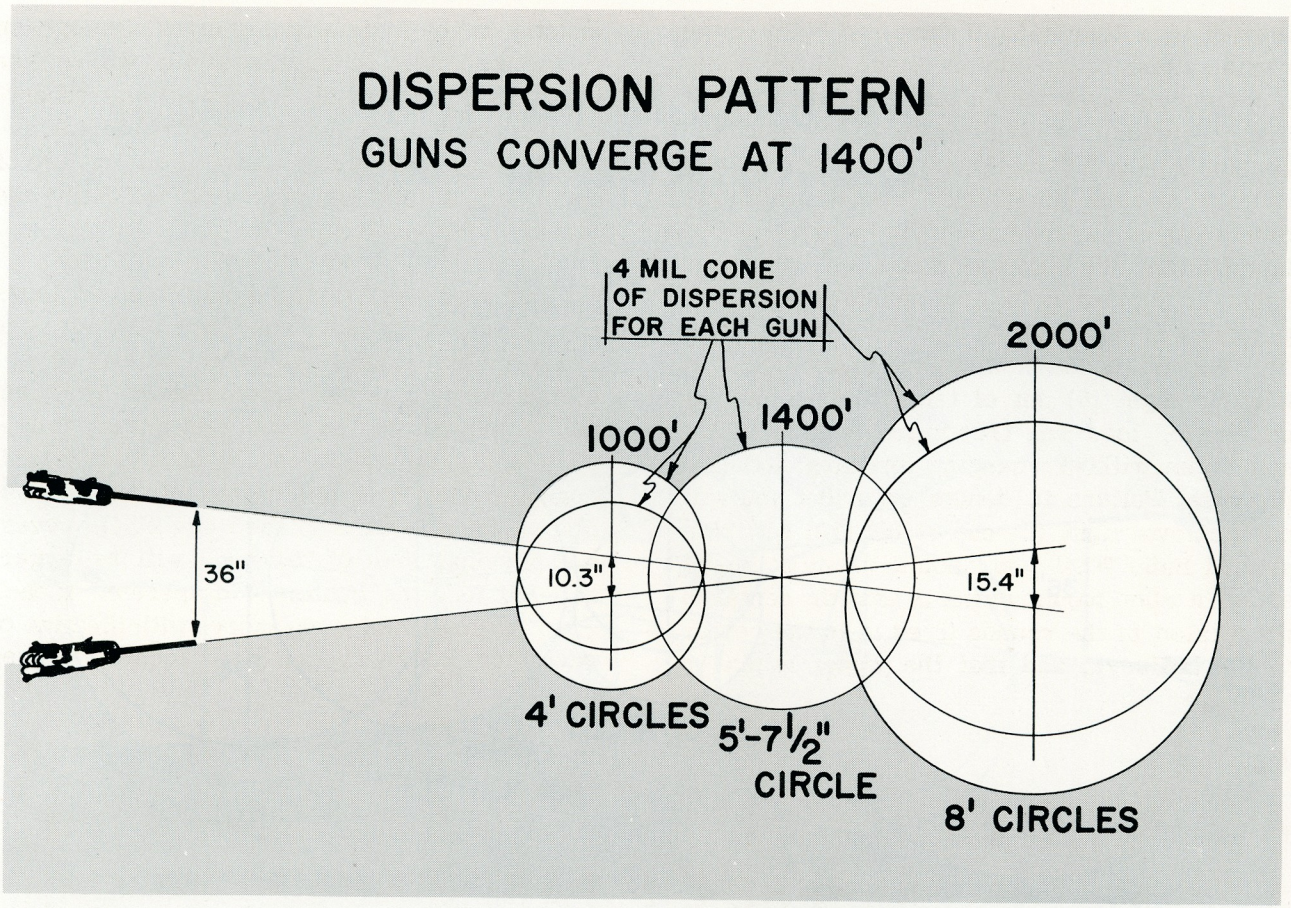


Figure 2

(Figure 1). If you harmonize for 1400 feet gun convergence, you should have 80% of the rounds fired fall in the four (4) mil cone at 1400 feet actual range. At any other range the cones of dispersion for each gun will be displaced slightly (Figure 2). The same applies to gun convergence at 1600 feet and 2250 feet. The following diagrams should clarify this (Figures 3 & 4). What I am trying to show from the diagrams is that regardless of the range at which you harmonize for gun convergence, you will have a satisfactory bullet density at any range from 1000 feet to 2250 feet. These are the approximate ranges that border the normal firing range of the M39 gun. It is evident that the all important thing is the position of the pipper, with relation to the center of dispersion of the guns and not so much at what range the cones of dispersion of guns coincide. Actually, even parallel harmonization is not so bad if the pipper indicates the center of dispersion.

I would like to show you now the effect of harmonization for different gun and sight convergence ranges when low angle strafing and when actually firing at a variety of ranges. A "rule of thumb" for understanding what happens is, the closer the range for which you harmonize for gun and sight convergence, the better off you are for low angle strafing. The larger the range for which you harmonize for gun and sight convergence, the worse it is for low angle strafing. The reason for this phenomena is that you have a stationary target and a fixed input to the sight, whether it be mechanically caged, electrically caged, or pegged.

The following diagram should graphically illustrate what happens at selected firing ranges when using the different harmonization ranges. This diagram is based on using the

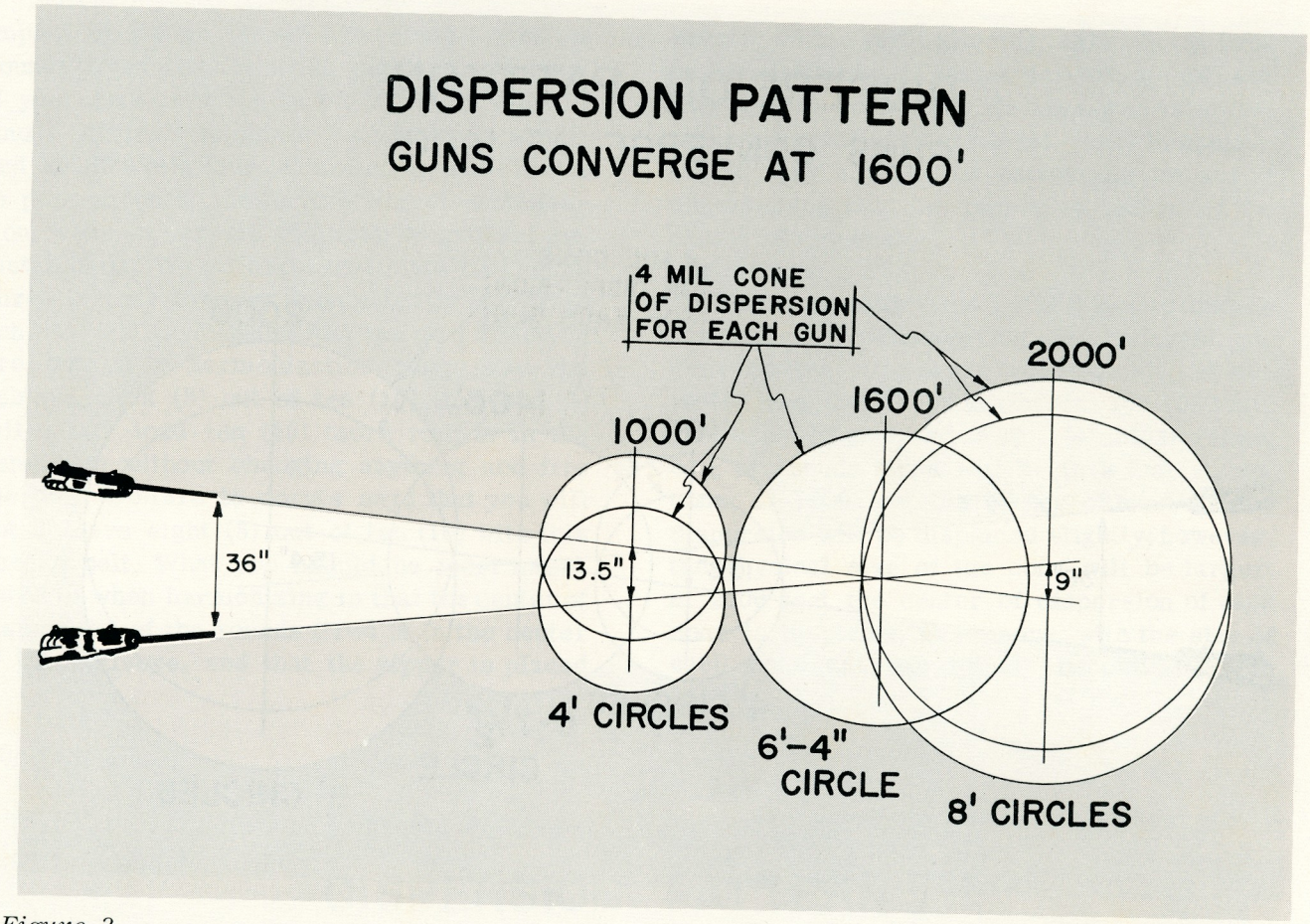


Figure 3

electrically caged pipper as a tracking index. Certain arbitrary conditions for firing were selected. If these change, then impact will change. If the airspeed is increased it will have the effect of moving down towards bullet trajectory due to trajectory shift. *Figure 5*

After studying the diagram it is evident that if all you are going to do is low angle strafing, the best range to harmonize for gun and sight convergence is 1000 feet but, before we jump to any conclusions, let's take a look at the effect of different harmonization ranges on air to air firing. After many years, we finally have a fire control system in the F-100 that should, if properly maintained, provide accurate lead computations for air to air gunnery at 20,000 feet. This, of course, is assuming that you fly the desired pursuit course and fire at the desired ranges. At higher altitude, the F-100 fire control system will overlead, at lower altitude it will underlead. This is due to a lack of correction for air density. If you harmonize for gun and sight convergence at 1000 feet, at any range in excess of 1000 feet you will have an underlead condition. Conversely, if you harmonize for gun and sight convergence at 2250 feet, you will overlead at any range less than 2250 feet. These statements are based on the assumption that all other components of the fire control system are operating perfectly. A very large assumption. Since practically all air to air firing is done from 1800 feet to 1000 feet.the best range for gun convergence for air to air gunnery is 1400 feet. However the advantages to be gained are so slight as to be ignored unless the other components of the fire control system are operating perfectly.

Let's be practical; experience has shown that when you are not hitting the target, 99 times out of 100, it is not the fault of the bullet dispersion, it is the fact that the pipper is

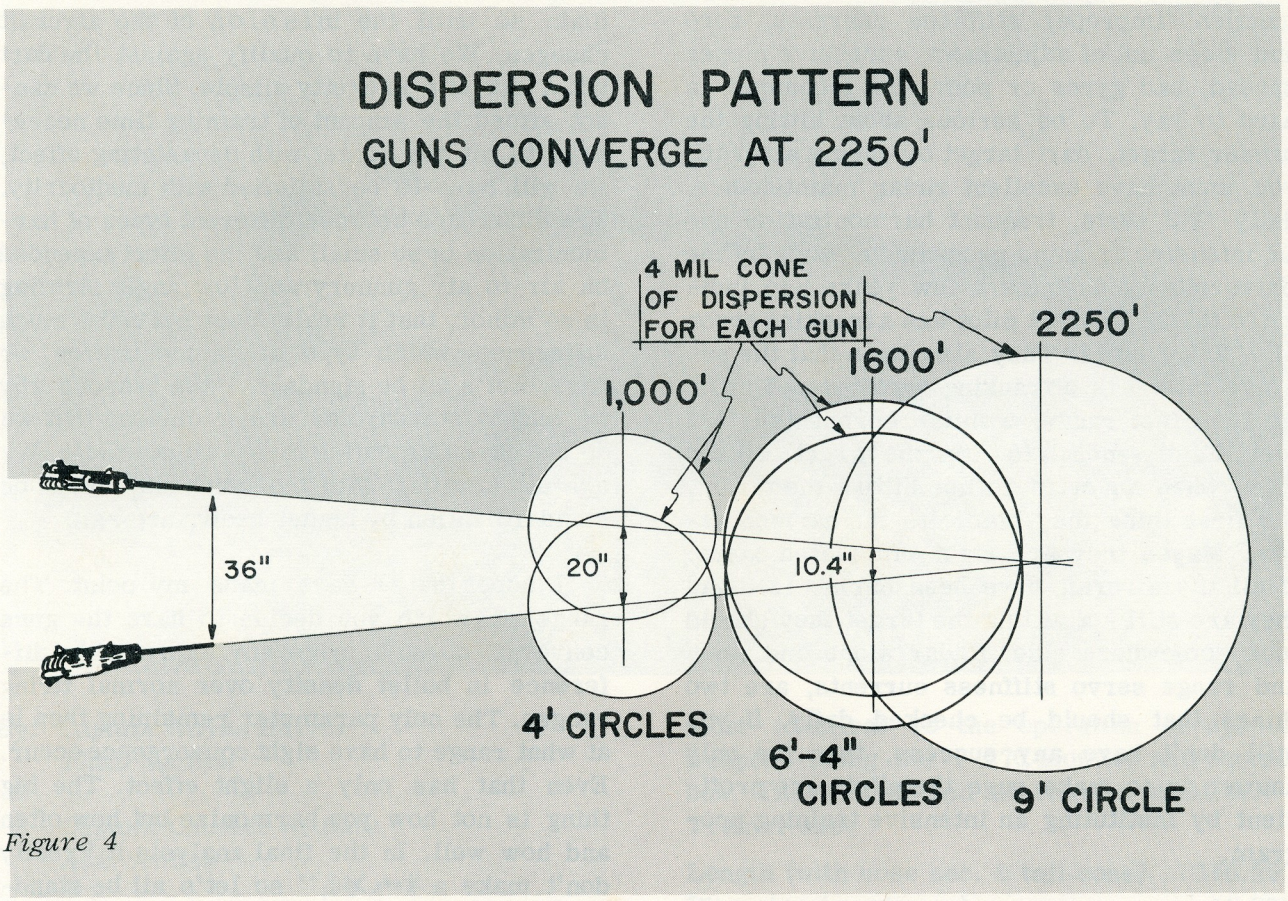


Figure 4

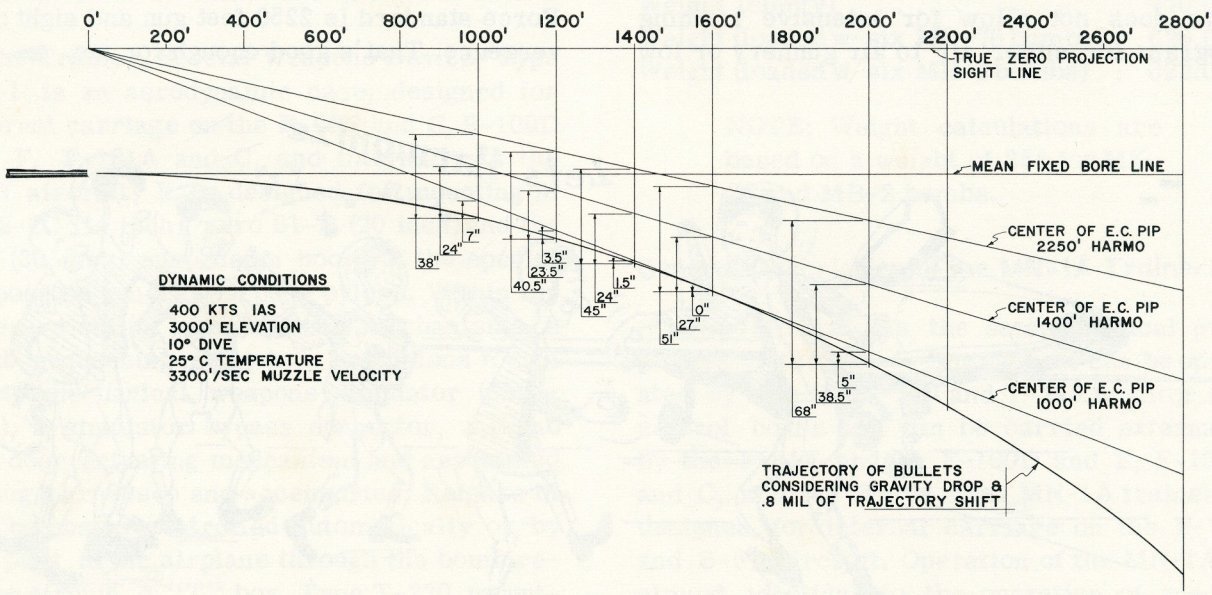


Figure 5

not indicating the center of the impact of the guns. Whether this is due to poor harmonization (remember the definition), radar malfunction, improper stiffness currents, zero and slope out of adjustment, excessive pipper spread, bad gyros or poor pilot technique, is hard to say. To be serious about hitting the banner target, dart target or enemy aircraft, you must have excellent radar maintenance, daily G-3 tests, frequent harmonization and an intensive training program. A study by the University of Chicago a few years ago indicated that the expert pilot has a tracking error of ± 2 1/2 mils. They also state that the average pilot has a tracking error of ± 5 mils. At 1500 feet range, 5 mils represents 7 1/2 feet. Easily enough to miss the target. All too often when an outfit is not hitting the target, the first thing they blame is the harmonization. Maybe they are right in isolated cases. If all the aircraft have been harmonized and they are still not hitting the target they should look somewhere else. Radar slope and zero, and range servo stiffness currents, are two things that should be checked daily. If you still don't have any success, then the only answer is to make sure the pilots are proficient by instituting an intensive training program.

The present mission of tactical fighter units does not allow for intensive training program for either air to air gunnery or low angle strafing. We are called upon only to be familiar with the techniques and procedures for air to air gunnery and it is likely to remain so until the mission of the aircraft changes. We have to qualify against the dart but 1 out of 4 is pretty simple. Since we cannot afford the amount of training time necessary to hit the target with devastating effect, we will have to be satisfied with mediocrity. The difference between different types of harmonization is so small and the effort expended on air to air gunnery and low angle strafing is so minor, that it really does not make much difference which type of harmonization we have. Let's all be standard - the reasons why we should standardize are so obvious that we do not have to mention them in this article. We are all familiar with the emphasis placed on standardization by higher headquarters.

I hope that I have made my point. The range at which you decide to have the guns converge doesn't make any appreciable difference in bullet density over normal firing ranges. The only parameter remaining then is at what range to have sight convergence occur. Even that has only a slight effect. The big thing is not how you harmonize but how often and how well. In the final analysis it "really don't make a ****," so let's all be standard and harmonize the same way. The Air Force standard is 2250 feet gun and sight convergence. That's good enough for me.

BOMB DISPENSERS

By: Captain Wayne Harris
TR&D Section

Captain Charles R. Hale
A&E Section

Description of the MN-1 and MN-1A Trainers

The Trainer, Special Weapons Device, Type MN-1 is an aerodynamic case, designed for external carriage on the F-84F and G, F-100D and F, F-101A and C, and internally in the B-57 aircraft. It is designed for mounting in the S-2C (14 inch), aero 61-B (20 inch) and the S-3 (30 inch) suspension hooks of the special purpose or general purpose pylons. Within the case are six (6) bomb ejecting mechanisms, a bomb sequencing relay box, provisions for an electromechanical weapons simulator (SMU-10B), a simulator bypass connector, a bomb bay door actuating mechanism and associated wiring harnesses and accessories. Release of the bombs is controlled automatically or by the pilot in the airplane through the bomb release circuit. A "T" box, Type T-270, mounted in the aircraft cockpit is used by the pilot to operate the trainer. This operation is almost identical to the operation of special weapons using the T-270 monitor and control box. The weights and dimensions of the MN-1 Trainer are:

Length (with nose sec. & tail cone) .	156.25"
Diameter (maximum)	17.00"
Weight (empty).	470.00#
Weight (loaded w/ six MK-76 bombs) .	620.00#
Weight (loaded w/ six MB-2 bombs) . .	622.00#

NOTE: Weight calculations are based on a weight of 25# for MK-76 and MB-2 bombs.

General Description of the MN-1A Trainer:

The MN-1A has the same physical properties as the MN-1. However, it can be operated by both the T-270 and T-249 monitor and control boxes and can be carried externally by the F-84F and G, F-100D and F, F-101A and C, and the F-104. The MN-1A trainer is designed for internal carriage on the F-105 and B-57 aircraft. Operation of the MN-1A is almost identical to the operation of special weapons using the T-270 and T-249 monitor and control boxes.

OPERATION OF MN-1 AND MN-1A TRAINER ON F-100, D&F AIRCRAFT

Operation of MN-1 with T-270 System

Walk around checkout.

Insure that the pylon switch marked "store tank and dispenser" is positioned for dispenser operation. Failure to comply with this step will result in inadvertent release of the MN-1 trainer if a release circuit is energized while airborne. (See Figure 1).

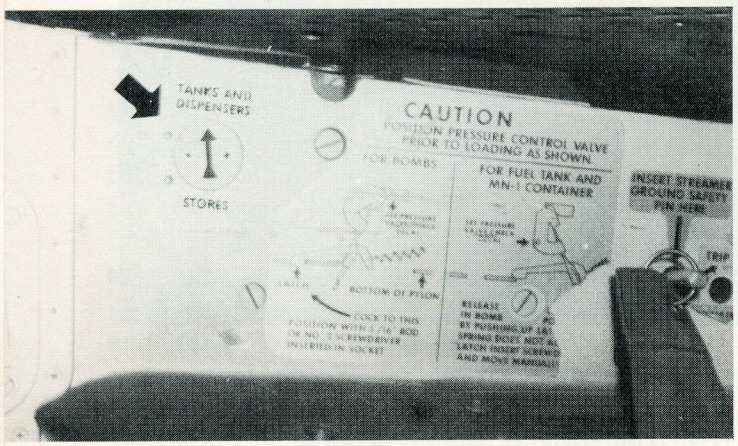


Figure 1

Insure that pylon cartridges are not installed before inspecting bombs for security and physical condition.

Intervelometer setting checked (position Nr. 1 at either 3 or 9 o'clock.) (See Figure 2)

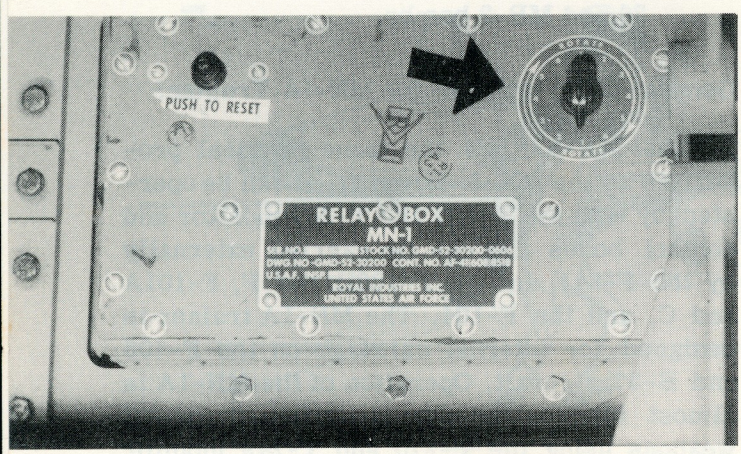


Figure 2

Install cartridges.

Insure MK-7 connectors in aft end of pylon are installed.

Insure that the six red flagged safety stop guards are removed prior to flight. (See Figure 1).

Cockpit Procedures.

After engine is started, energize the following circuit breaker switches on the T-270 panel, Htr power; Fin power and IFI power.

Position "Ext/Ret" Switch to "Ext" position (doors will close).

On Range Procedures.

Momentarily depress IFI button to open bomb bay doors on trainer. (Opening of the trainer doors takes approximately 9 seconds. The IFI light will come "on" when the doors are open).

To release a bomblet, activate the normal bomb release system by operating the appropriate switches in this system. The trainer doors will automatically close after a bomblet is released. (IFI light goes "out" when bomb is released).

> NOTE: The pilot may desire to close the MN-1 Trainer bomb bay doors without releasing a bomblet. To accomplish this, the heater power circuit breaker switch should be switched from "ON" to "OFF" to "ON." The trainer doors will close when the heater circuit is reenergized.

For release of the remaining bomblets the IFI operate button must momentarily be depressed and the normal bomb release system energized after each drop.

For emergency release of the MN-1 Trainer, consult appropriate T. O.

Operation of MN-1A with T-270 System.

Walk-around checkout.

Same as MN-1 with T-270 system.

Cockpit Procedures.

After engine is started energize Htr Power Switch on T-270 panel for twenty (20) seconds. Turn Htr Power Switch off and immediately back on (doors will close). Leave Htr Power Switch on until last bomb is dropped.

On Range Procedures.

Energize IFI Power Switch and momentarily operate IFI operate button (doors will open and IFI in light will come on when bomb bay doors are open. It takes approximately 9 seconds for doors to open).

Release bomblet same as MN-1 with T-270 system.

> NOTE: The pilot may desire to close the MN-1A trainer bomb bay doors without releasing a bomblet. To accomplish this, turn the IFI circuit breaker OFF, then turn the Htr Power Switch from ON to OFF to ON. The trainer doors will close when the Htr circuit is reenergized. After the IFI in light goes out (indicating doors are closed or closing) turn IFI circuit breaker ON.

For release of the remaining bomblets the IFI operate button must be momentarily depressed (doors will open) and the normal bomb release system energized after each drop.

For emergency release of the MN-1A trainer, consult appropriate T. O.

Operation of MN-1A Trainer with Present T-249 System

Walk-around checkout.

Insure that 10 SL type connector and the stub pullout connector in the forward section of the pylon is properly engaged with MN-1A trainer.

Insure that the pylon switch marked "store tank and dispenser" is positioned for dispenser operation. Failure to comply with this step will result in advertent release of the MN-1 trainer if a release circuit is energized while airborne. (See figure 1)

Cockpit Procedures.

Energize T-249 power switch.

Operate press-to-test light for presence of light indication. This insures that the pullout cables are properly installed in the trainer.

On Range Procedures.

To operate bomb bay doors of the MN-1A trainer, rotate T-249 selector switch from "safe" to "Gnd" or "Air" position.

Operate press-to-test circuit.

To release a bomblet, activate the normal bomb release system by operating the appropriate switches in this system. The trainer doors will automatically close after a bomblet is released.

> NOTE: The pilot may desire to close the MN-1A Trainer Bomb bay doors without releasing a bomblet. To accomplish this rotate the T-249 selector switch from "Air" or "Gnd" to "Safe" to "Air" or "Gnd". The trainer doors will close when the T-249 selector switch is repositioned to "Air" or "Gnd".

Before additional bomblets can be dropped, the Selector Switch must be moved from "Gnd" or "Air" to the "Safe" position and wait 2 - 3 minutes (under airborne conditions). Then rotate Selector Switch to "Gnd" or "Air" position. Doors will then reopen.

MAINTENANCE OF THE MN-1 AND MN-1A TRAINERS

Maintaining the MN-1 and MN-1A Trainers is a time consuming job, but worth the effort when the operations personnel keep the squares filled. When proper inspection and maintenance procedures are adhered to, by weapons systems personnel, very low malfunction rates can be obtained on bombing missions (i.e. since emphasis has been placed upon the inspection and maintenance procedures, outlined below, the Fighter Weapons School has dropped 2515 MK-76 bombs with 12 failing to release).

When your organization received the MN-1 and MN-1A Trainers there are certain preventative maintenance measures that should be adopted:

1. Safety all electrical connectors.

2. Inspect wiring for cold solder joints.

3. Replace nut plates on front and rear doors with self locking nuts.

4. Peen locating pins and bolts into ejector bomb pads.

Selection of Bombs:

Selection of the proper bomb is very important! There are two manufacturers of MK-76 Mod 2 bombs - the Waycross and Hoffman Companies. The Waycross bomb, identified by a smooth body surface, is poorly made and no two bombs are shaped alike. Some are too large and when loaded in the trainer are difficult to release. (Check these bombs carefully). The Hoffman bombs, identified by a perforated ribbed body, are normally within tolerance. However, both bombs can be used provided a template is used to determine proper tolerance.

TRAINER MALFUNCTIONS

Most of the malfunctions of the MN-1 Trainer can be directly attributed to the bomb release and IFI interlock actuator striker plate located in the upper right front portion of the trainer. The plat is not suitable for the purpose it fulfills and must be inspected prior to each loading to insure sufficient pressure is applied to the bomb release and IFI light micro switches. If the striker plate becomes weak and fails to properly close the micro switches, a *complete failure* of the trainer will result!

Some of the MN-1 trainers contain the wrong type bomb ejector pads. Two types of pads are in use; the MK-76 bomb (blue & red) and the MB-2 bombs (white). Make certain that the proper pad is used. Failure to observe this precaution will result in bombs failing to release properly. The blue colored pads go forward when the MK-76 Mod 2 is used.

Insure that absolute quality supply discipline is observed. MN-1 trainer spare parts are in limited supply and can be ordered on immediate replacement requirement only.

INSPECTION PROCEDURES

In addition to the inspection procedures outlined in technical publications applicable to the MN-1 trainer, the following inspections should be performed prior to loading bombs.

INSURE:

The bomb release and IFI striker plate is applying positive pressure on the micro switches.

The bomb ejector pads make a tight fit on the plunger ejector cylinder.

All connectors are properly safetied.

The bomb toggles or claws are in serviceable condition.

The intervalometer is operating properly.

Trainer doors are not bent and all nuts and bolts are tight.

YANK AND BANK

By: *Captain Hal Vincent, USMC*
UMF 334 MCAF
El Toro, California

Have you, as a fighter pilot, ever wondered just what is the best speed for your particular airplane, when trying to set up a maximum-rate evasive turn or yo-yo? Have you wondered if it is really "worth" it to slow down to the lowest speed possible when trying to achieve a minimum radius turn? Pilots with a great deal of tactics experience eventually learn, by trial and error, the most effective fighting airspeeds for their airplane. In a few moments of time, however, you can easily compute the minimum radius of turn and maximum rate of turn, in degrees per second, for your airplane. Using these airspeeds, you can then fight or evade, knowing that you are always getting the most out of your particular bird.

Following are the steps required to obtain minimum radius and maximum rate turns, with an example to illustrate the procedure:

1. Obtain the strength (Vn) diagram for your airplane.

2. Pick points of Indicated Airspeed and Total g off the diagram.

3. Convert Indicated to True Airspeed and Total g to Radial g.

4. Using formulas, insert values obtained above.

5. Plot radius of turn and rate of turn curves.

6. Pick off minimum radius and maximum rate indicated airspeeds.

EXAMPLE (Steps 1 & 2)

Let us take the Vn diagram for a hypothetical airplane with performance capabilities closely approximating that of the F-100D. From this diagram, at 25,000 feet altitude, we choose point A with the resultant indicated airspeed and total g. *Figure 1*

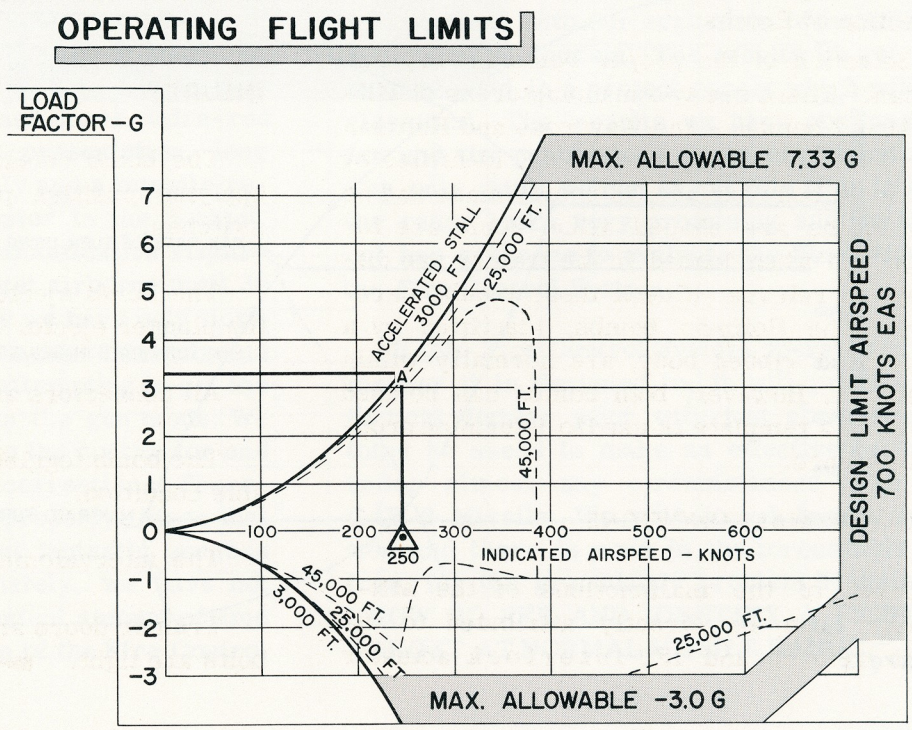


Figure 1

Step 3

We convert the 250 knots IAS to a True Airspeed of 355 knots and convert the 3.2 total g to radial g by the formula:

$$GR = \frac{Gt^2 - 1}{} \text{ or } GR = 10.2-1, \quad GR = 3.02$$

Step 4

Use radius of turn formula $R/T = \frac{.0887\ (V)^2}{Gr}$

Where R/T = Radius of turn in feet
V = TAS in knots
Gr = Radial g

$$R/T = \frac{.0887\ (355)^2}{3.02} = 3650 \text{ feet}$$

Use rate of turn formula -

$$\text{Rate of Turn} = \frac{1090\ (Gr)}{V}$$

$$\text{Rate of Turn} = \frac{1090\ (3.02)}{355} = 9.3 \text{ deg/sec}$$

Where Rate of Turn = deg/sec
Gr = Radial g
V = TAS in knots

Step 5

Plot a succession of points obtained by the above method.

Step 6

From the plotted curve, pick off the minimum radius and maximum rate turn for your bird. A sample plot, obtained by the above method and closely approximating the F-100D, is presented in Figure 2. The minimum radius of turn occurs near 250 knots and the maximum rate of turn (approximately 12.7 deg/sec) occurs near 400 knots. Using a maximum of 4 g's in a hard turn, the maximum rate of turn occurs at 275 knots indicated airspeed.

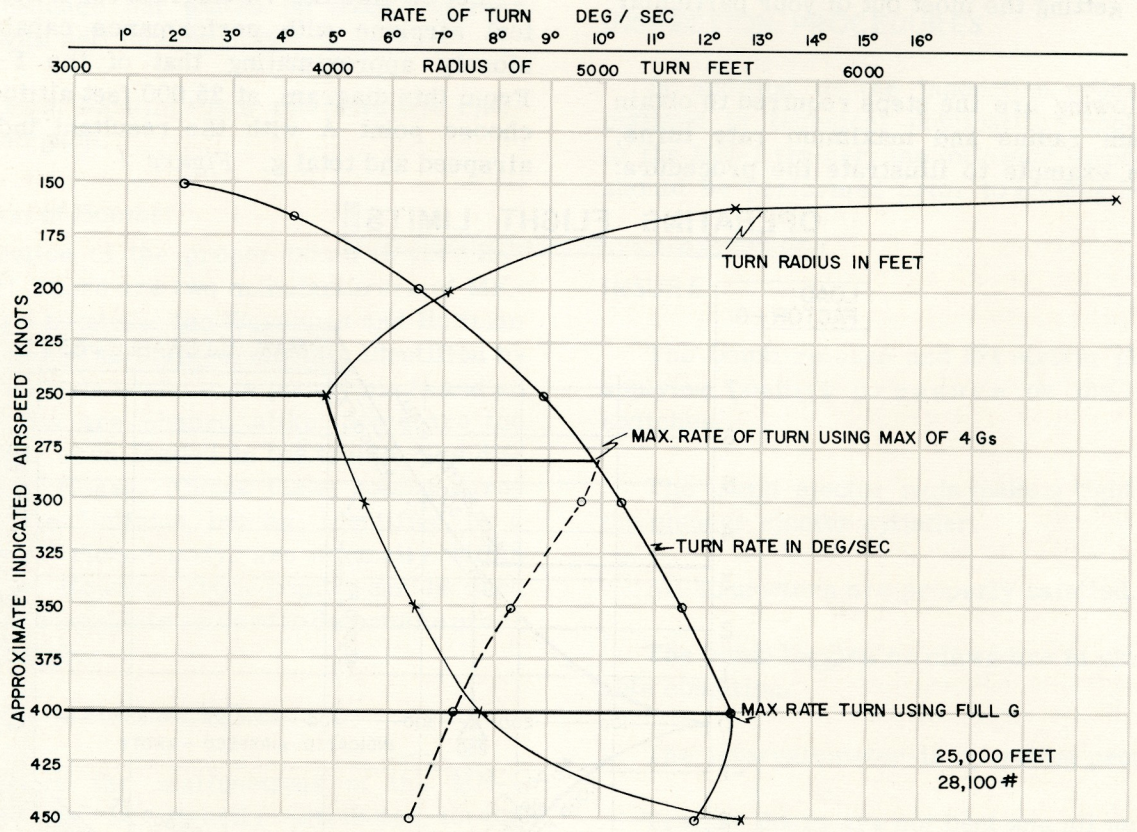

RATE OF TURN DEG / SEC
1° 2° 3° 4° 5° 6° 7° 8° 9° 10° 11° 12° 13° 14° 15° 16°
3000 4000 RADIUS OF 5000 TURN FEET 6000
150 175 200 225 250 275 300 325 350 375 400 425 450
APPROXIMATE INDICATED AIRSPEED KNOTS
TURN RADIUS IN FEET
MAX. RATE OF TURN USING MAX OF 4 Gs
TURN RATE IN DEG/SEC
MAX RATE TURN USING FULL G
25,000 FEET
28,100 #

Figure 2

ASG-20

By: Captain Bruno A. Giordano
TR&D Section

On 1 July 1959, we began installation of the ASG-20 Fire Control System in an F100F assigned to the TR&D Section. The system consists of numberous black boxes, infra-red (IR) search with cockpit presentation, long range radar for range only and a missile release computer and indicator in the cockpit. Because of the extensive modification required the first flight did not get airborne until 30 July 1959. Since that time we have only flown a limited number of sorties due to the extreme difficulty we encountered attempting to get the radar to work properly in the gun mode. We finally returned the set to the contractor and they made the necessary corrections. Thereafter, the set functioned properly. Since that time we have had almost fantastic success with the radar. Unfortunately, we have not been able to devote a sufficient amount of time and effort to the IR portion of the Fire Control System, to make any positive or leading statements. The aircraft is scheduled for a GAM-83 modification that will require ten (10) weeks. At the end of the modification we will continue with our evaluation of the ASG-20 Fire Control System. The results we get will be published in a project report which will be classified. The results we have obtained so far and the conclusions drawn are classified. The only thing we can say at this time is that the radar looks very promising and we have not had a chance to evaluate the IR portion of the Fire Control System.

If this Fire Control System operates in the manner it is designed to, it will provide the tactical fighter pilot with just about everything he needs to make an effective delivery under almost any circumstances with the GAR-8 Missile. We still do not have a solution and there is none in the foreseeable future, for the granddaddy problem of them all "HOW TO SEE AND IDENTIFY A FIGHTER TARGET AT NORMAL MISSILE RANGE." ►

quiz???

1. With the A-4 sight mechanically caged, setting the wingspan lever on 30 feet will give a_____mil reticle radius.

   a. 100 b. 50 c. 25 d. 15

2. The minimum tracking time required to assure an accurate sight solution is:

   a. 1 sec b. 2 sec c. Generally (1) one times the time of flight of the projectile. d. Generally 2/3's the time of flight of the projectile.

   Situation: When making an airborne radar calibration check, the range dial reads 1400 feet with radar ranging and 1200 feet using manual ranging diamonds spanning the wing tips.

3. If radar ranging is used, the sight will:

   a. Underlead b. Overlead

4. Approximately how much?

   a. 4 - 8 feet b. 8 - 12 feet c. 12 - 16 feet d. 16 - 20 feet.

5. Name three indications of a radar lock-on.

6. You have had the sight and radar "ON" for five minutes and have just completed the rocket system check. Hitting the target selector button does not return the sight to gunfire function. What is the probable cause?

7. The electrical caging system cuts out radar ranging so that recticle size and range dial reading do not vary with changing range.

   a. True b. False

8. If the minimum manual range is set at 1200 feet, the outer limit of manual ranging should be set at a minimum range of:

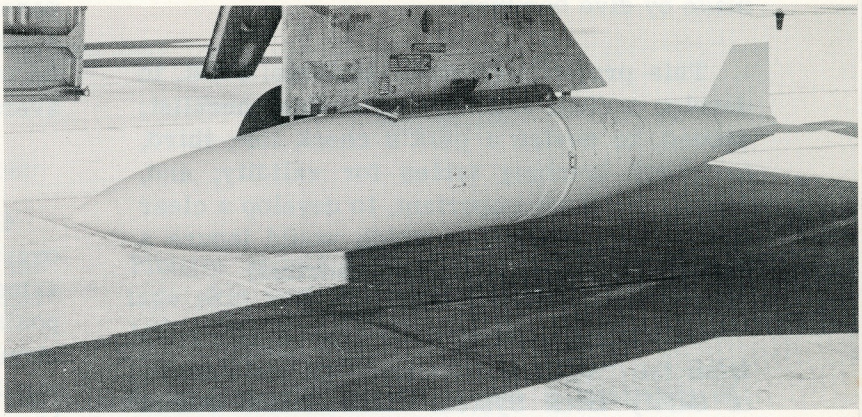
   a. 2200 feet b. 2400 feet c. 2600 feet d. 2800 feet

9. When operating at low altitude (eight to ten thousand feet above the ground) what can you do to prevent random lock-on's from the ground?

10. If reticle size and range dial reading do not vary when the throttle twist grip is rotated, how can you determine whether or not the sight can be used as a fully computing sight?

ANSWERS ON PAGE 48

MD-6



By: Captain John C. Holley
TR&D Section

The MD-6 practice bomb was recently introduced into the USAF inventory as a standard training shape. This item more closely resembles the real thing in loading procedures, flying characteristics, trajectory and appearance than any previously used practice bomb. It has the same external configuration and, consequently, very closely simulates the drag characteristics of the parent weapon.

Two versions of the MD-6 are available for use - fixed-fin and folding-fin models. The fixed-fin version may be used on the C, D and F models of the F-100 and on the F-101A. (When used on the F-100D or F, it is attached to the left intermediate wing station). The folding-fin model may also be carried on the F-100D and F, as well as on the center-line pylon of the F-104.

Both bombs have the same basic major components - nose, center, aft and tail cone sections.

The nose section is hollow, has a steel cap on the extreme front end and attaches to the front end of the center section.

The center section (which consists of a case, a cast back-up ring, two handling lugs, two suspension lugs, and a cast coupling ring) is filled with concrete, which may be either Portland Type I (requiring 28 days for curing) or Type III which cures in only seven days. This section is attached, in turn, to the aft section by a V-band coupling ring.

The aft section houses a six-pound spotting charge, which is composed of black powder and aluminum powder. This charge (Type MA-1) emits a flash along with a smoke cloud. To preclude inadvertent detonation of the spotting charge, the following safety devices have been installed: an arming pin, a release lever, an arming wire and a safety wire.

The tail cone, which attaches to the aft section, is of two types: a folding-fin configuration (with a motor-driven folding fin, a double fixed fin and a single fixed fin) and a fixed-fin model which is provided with a double and two single fixed fins.

All procedures to be used in preparation for use, assembly, installation, operation and maintenance are covered thoroughly in a Preliminary Manual, AF TO 11N-PB(MD-6)-2, and should be followed closely when assembling the MD-6.

Recently the FWS ran a project in which a total of eighteen MD-6's were dropped. Eleven of these drops were accomplished

over-the-shoulder delivery and seven were made by dive bombing.

This project was multi-purpose: First, to develop a clear and concise loading checklist; second, to devise a pilot's check list; third, to check bombing tables for validity; and, fourth, and most important, to develop a clear and concise procedure which would insure a high percentage of successful sorties.

Our loading checklist was taken primarily from the "Operational Check-out and Testing of Safety Lock System" Manual that comes with the 712 Mod kit.

In our efforts to determine cause and effect as a means of eliminating airborne aborts, we actually dropped an MD-6 on an MJ-1 bomb trailer and removed the LABS gyro's from the aircraft in order to simulate an over the shoulder maneuver by rotating the gyros.

Any malfunctions occuring during the loading check were promptly corrected or different equipment was installed.

All drops were accomplished from type VII center-line pylons which had been modified according to TO 712. Seven aircraft were used in our drop tests - six F-100D's and one F-100F. Each time a different aircraft was used, a different pylon was also used. In this way, we were able to check reliability on more different items of use. Findings made from these drops are as follows:

1. Minimum torquing (250 inch pounds) on the sway braces should do away with "no-release" type malfunction, if the rest of the system checks out.

2. Suspension-lug clearance is very critical. An aluminum template was constructed for use in measuring lug clearance (1.48" ± .02"). This template proved to be a quicker and more accurate means of measurement than by measuring with a ruler.

3. Bomb tables developed for use on the parent weapon are well suited for the MD-6. Plots ranged from "excellent" to "very good" on over the shoulder drops. Dive bomb drops averaged out as "good."

4. If dry runs are to be made prior to over the shoulder release of an MD-6, the armament selector should be in the "off" position and the special stores unlock handle should be in the "locked" position while making the runs. The LABS should be cycled prior to selecting special stores and unlocking the "special stores unlock" handle. One inadvertent release was attributed to failure to cycle LABS prior to actuating armament switches.

5. When carrying the store on the center-line pylon, the speed brakes should be manually locked prior to start and particular care should be exercised to assure that the speed brake emergency dump lever is in the "off" position and that the speed brake switch is in the neutral position prior to applying power to the aircraft. During one start, the dump lever was inadvertently left in the dump position and the speed brake switch was at "down." Even though the oversight was hurriedly corrected, the speed brake extended enough to strike the bomb, and slight damage was sustained by the speed brake.

CONCLUSION: The MD-6 practice bomb is a valuable training item for aircrews. It is recommended that this item be used only with the pylons and aircraft that have had the TO 712 Mod kit installed and that each loading be given personalized loading as would the parent weapon.

The following is out loading and checking list (as used on this project - with exception of actual dropping of MD-6 on the MJ-1 Bomb Trailer) and the pilots check list:

AIRCRAFT PRE-PYLON INSTALLATION CHECK

(TYPE VII)

ACTION	RESULTS
1. Insure that TO 1F-100-712 has been complied with.	
2. Pull "special stores unlock" handle to the out and locked position. Measure plunger extension at the centerline station.	Plunger should have clearance between fuselage skin and bottom of plunger of 1 9/32" ± 1/8".
3. With "special stores unlock" handle in the "unlock" position measure travel length of the handle.	Handle should be pulled out a minimum of 2 1/16".
4. Replace "special stores unlock" handle to the stowed position. Measure plunger extension at centerline station.	Plunger should now have clearance between fuselage skin and bottom of plunger. Between 0" to 1/16" above.
5. Measure "speed brake limit switch" for correct adjustment.	Should be 1/16" + 1/8" -0"
6. Inspect special stores cannon plug.	All pins clean and firm in setting, no damage to pins.

PYLON PRE-INSTALLATION CHECK

(TYPE VII)

ACTION	RESULTS
1. Insure that TO 1F-100-712 has been complied with.	
2. Inspect cannon plugs and wiring.	All pins clean and firm in setting, no damage to pins.
3. All sway braces installed and in "full up" position.	No binding in adjusting screws.
4. Manually operate speed brake disconnect rod.	Should move freely in track.
5. Check attaching hooks, linkage and pylon post.	No evidence of cracks and/or mistreatment.
6. Inspect cartridge container cavity.	No foreign matter within cavity. (Ejection cartridge holder should be turned backwards to indicate a safe condition)

Install pylon on aircraft IAW TO 1F-100D-2-11.

Preparation of aircraft for "power on" system and "special stores unlock" mechanism check.

a. Insert all landing gear down-locks.

b. Pull interim tank jettison circuit breaker located in c/b panel station 200 if external tanks are installed.

c. Insure that aircraft has ground wire attached.

d. Connect 28V DC power source to the aircraft.

e. Set switches and controls as follows:

Switch or Control	Position
Armament Selector Switch	Special Stores
Release Signal Selector	Manual
Nose Gear Torque Link	In-Flight Position
Landing Gear Position c/b	Out

ELECTRICAL CHECK OUT PROCEDURES

ACTION	RESULTS
1. Pull "Special Stores unlock" handle from stowed position and cock bomb rack.	If unable to cock, recycle handle and cock.
2. Push "Special Stores unlock" handle to stowed position.	Bomb rack is now cocked and locked (refer to decal on pylon for safe cocked position).
3. Attach voltmeter to pylon jettison breech and press bomb button momentarily.	"Special Store unlock" indicator light remains out, bomb rack remains cocked and locked, no voltage indicated at pylon jettison breech.
4. Pull "Special Stores unlock" handle to the unlocked position.	"Special Stores unlock" indicator light illuminates.
5. Depress bomb release button momentarily, (voltmeter at pylon jettison breech.)	Bomb rack trips immediately, "Special Store unlock" indicator light goes out, no voltage indicated at pylon jettison breech.
6. Stow "Special Stores unlock" handle.	

EMERGENCY JETTISON CHECK

WARNING: Check that interim tank jettison circuit breaker in c/b panel is pulled and all ejector cartridges removed if external tanks are installed.

ACTION	RESULTS
1. "Special Stores unlock" handle stowed, bomb rack cocked, armament selector to "Jettison All" position.	
2. Attach voltmeter to pylon jettison breech; depress bomb button momentarily.	"Special Stores unlock" indicator light is out, bomb rack remains cocked, and locked, no voltage is indicated at pylon jettison breech.
3. Pull "Special Stores unlock" handle to unlock position.	"Special Stores unlock" indicator light illuminates.
4. Attach voltmeter to pylon jettison breech, depress bomb button momentarily.	Bomb rack trips immediately, "Special Stores unlock" light goes out, 28 volts indicated on voltmeter at pylon breech.
5. Cock bomb rack and stow "Special Stores unlock" handle.	
6. Depress emergency jettison button momentarily.	Bomb rack remains cocked and locked.
7. Attach voltmeter to pylon jettison breech, pull "Special Stores unlock" handle from stowed position. Momentarily depress emergency jettison button.	Bomb rack trips immediately, "Special Stores unlock" indicator light goes out, 28 volts indicated on voltmeter at pylon jettison breech.
8. Cock bomb rack and stow "Special Stores unlock" handle.	"Special Stores unlock" indicator light remains out.

EMERGENCY JETTISON STORES HANDLE CHECK

WARNING: Do not perform this check with external tanks or stores on A/C.

NOTE: Following results are obtained with aircraft changed by TO 1F-100-677 only.

ACTION	RESULTS
1. Attach voltmeter to pylon jettison breech, pull out emergency jettison store handle.	"Special Stores unlock" indicator light remains out, bomb rack remains cocked, no voltage indicated at pylon jettison breech.
2. Pull "Special Stores unlock" handle from stowed position.	"Special Stores unlock" indicator light comes on, bomb rack trips immediately, indicator light goes out, 28 volts indicated at pylon jettison breech.

MD-6 PRE-LOADING CHECK

ACTION	RESULTS
1. Adjust suspension lugs for clearance as shown on decal.	Clearance 1.48'' ± .02''.
2. Inspect quick disconnect receptacle on aft section.	Check that pins are firm and unbent and that entire receptacle is free from foreign matter.
3. Check entire bomb for security of attached parts.	Fin fairing screws and V-band. Check for alignment of case sections.

Prior to bomb installation on pylon, aircraft should be on hard surface, with space insured to facilitate movement of ground handling equipment during loading. Aircraft should be refueled and all wheels chocked. At this point the MD-6 is installed in accordance with appropiate -16.

FIN EXTENSION CHECK

ACTION	RESULTS
1. Recheck all landing gear down locks inserted on aircraft.	
2. Connect 28 volt DC power to aircraft.	
3. Turn power switch on T-249 on.	
4. Raise gear handle.	Fin should extend to down position, motor stops running when fin is fully extended.
5. Lower gear handle.	Fin should retract to position alongside right horizontal fin and motor should stop when fin is fully retracted.
6. Turn all switches and controls off, reset circuit breakers, connect nose gear torque link.	Check complete.

NOTE: During checks on aircraft, pylon or bomb, if clearances are not within tolerances, or any electrical malfunction occurs, check procedures as outlined in appropiate -11 and also TO 1F-100-712.

MD-6 PILOT'S CHECK LIST

A. PRE-FLIGHT

1. Aircraft

a. Check all cockpit armament switches off, "Special Stores unlock" handle in stowed position (IN).

b. Check power switch on T-249 off, all circuit breakers in.

c. Check speed brakes emergency dump lever to "OFF" (full aft)

d. Check speed brake switch to neutral position.

e. Check landing gear struts for proper extention.

f. Check speed brakes fully closed and locked. (If not locked have the crew chief remove panels and manually lock speed brakes in the up position.

2. Pylon

a. Check for MOD 712 c/w should be stamped on left forward side.

b. Check ejector cartridges not installed.

c. Check ground safety pin in and that it is easily moved in and out. (If pin is binding, bomb release mechanism may not be fully cocked.)

d. Check diagram and window for bomb release mechanism fully cocked (both sides of pylon).

e. Check swaybrace pads torqued to 250 inch lbs. and locked down. (Check with armament crew)

f. Check all panels on pylon fastened.

g. Check speed brakes pin for extention against bomb (front end of pylon) not bent, free from foreign matter.

3. Bomb

a. Check handling lugs removed.

b. Check overall condition and security (all section and fairing fasteners and screws secure).

c. Check security of fins and position of bottom vertical fin to retracted position.

d. Check retracted fin fairing not binding on tail cone fairing on underside.

e. Check quick disconnect electrical plug for security.

f. Check spotting charge safety wire removed.

g. Check spotting charge arming wire secure.

h. Check ejector cartridge installed.

B. AFTER START (AC GENERATOR ON-LINE)

1. Switches

a. Armament selector switch to OFF.

b. T-249 power switch ON.

c. Circuit breakers on T-249 control panel IN.

C. BEFORE TAKE-OFF

1. Pull "Special Stores unlock" handle out and lock. (Rotate to 6 o'clock position to lock).

2. Check for illumination of amber light next to unlock handle. (If no light, bomb release may not be fully cocked or, ground safety pin may still be installed).

> NOTE: Unlocked handle should not be intentionally pulled if ground safety pin is still in; it may damage the pylon bomb rack. .

D. TAKE-OFF

1. Normal - check charts for increase in gross weight. No unusual yaw or lift-off characteristics.

2. Vertical fin on bomb will extend when gear handle is placed in the UP position.

E. AFTER TAKE-OFF

1. "Special Stores unlock" handle to stowed position - check light out.

F. PATTERN

1. Normal - use switch procedures as briefed for particular type delivery.

2. "Special Stores unlock" handle out, amber light illuminated to release. If no light, recycle handle. Lock handle out by rotating to 6 o'clock position.

3. Upon release of store, light will go out.

G. RETURN TO BASE

1. Switches:

a. Armament select OFF, "Special Stores unlock" handle IN.

H. EMERGENCY PROCEDURES

1. Abort on take-off - Jettison bomb if barrier engagement is imminent. (unlock handle must be pulled out to jettison store) Actuate salvo button or arm select to "Jettison All", depress bomb button.

2. No Release

a. "Special Stores unlock" handle in stowed position.

b. T-249 power switch ON. Required to retract fin when gear if extended.

CAUTION: A successful barrier engagement is improbable if bomb is retained. "Special Stores unlock" handle must be in the unlocked position in order to jettison the bomb or pylon to insure barrier engagement.

ANSWERS TO QUIZ

1. 25 mils. Using the formula $\frac{\text{wingspan}}{\text{range dial}} = \frac{\text{reticle diameter}}{1000}$ we find the reticle diameter is 50 mils. This gives a radius (pipper to bottom diamond) of 25 mils.

2. Generally 2/3's the time of flight of the projectile.

3. Overlead. Radar is indicating to the sight that the target is farther away than it actually is.

4. 12 to 16 feet. The miss distance on the target (center of pipper to center of impact) is approximately 6 - 8 feet for each 100 feet of range error.

5. a. Radar lock-on lite illuminates
   b. Reticle becomes brighter (F's; -90D's, King's Lift modified aircraft)
   c. Reticle increases or decreases in size.
   d. Range dial reading changes from rest range to range to the target.

6. The radar is probably removed from the aircraft. Remember, the relay used to return the function switch to gunfire function is located in the radar set.

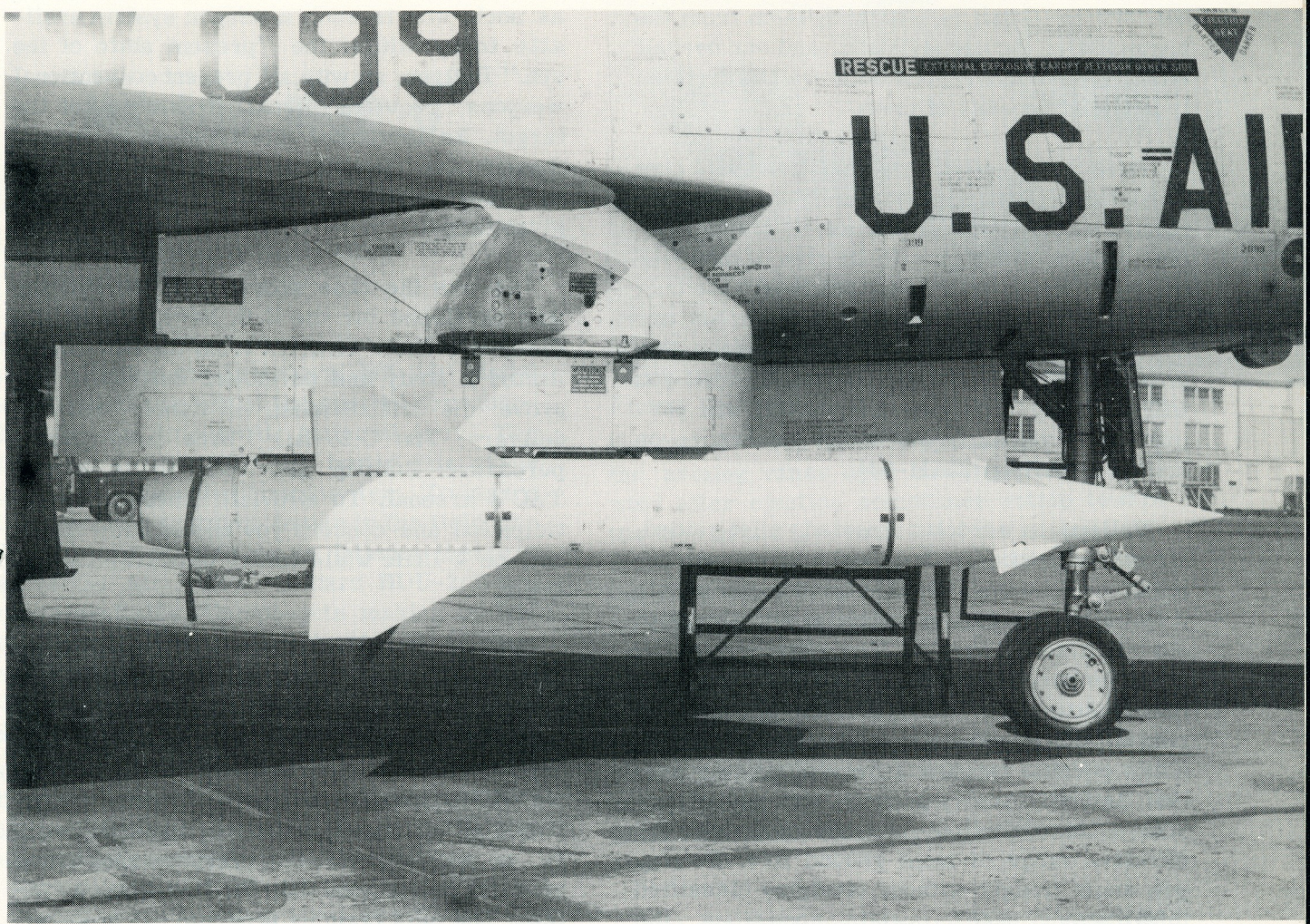
7. False. The electrical caging system has no effect on information going to the sight head. It merely adds stiffness current to the gyros.

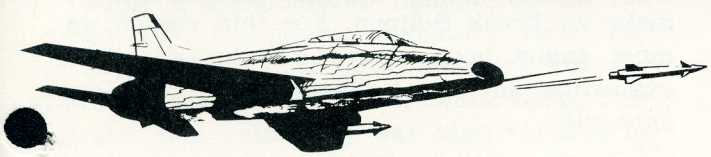
8. 2600 feet. The manual ranging span should be at least 1400 feet.

9. Place the range sweep rheostat to the "min" position. Now the radar will lock-on only out to approximately 5000 feet.

10. Rotate the throttle twist grip slowly. Clockwise motion should cause the reticle to rise slightly - decreased range. Counter clockwise motion should cause the reticle to drop slightly.

Perform the airborne gyro check - porpoise and yaw the aircraft. If the gyros check out OK, more apparent reticle movement at 2400 feet (just out of detent) than at 1000 feet (full clockwise), the computing sight can be used. However, reticle size and range dial reading will not vary.





BULLPUP
Fighter Pilot's Equalizer

By: Captain Robert M. Thor
TR&D Section

How many times have you made a perfect bomb run, pickled, pulled out and then observed a gross error at impact? Frustrating isn't it? You try to analyze what went wrong and you wonder: Did the bomb hang up? Were the fins bent? Is the ejection velocity correct? Who computed this sight picture anyway?

How many times have you made a perfect rocket pass, fired and then watched the rocket corkscrew or cavort wildly about? Again a frustrating circumstance. What went wrong? Were the fins bent or lost? Was the propellant grain cracked?

The answers to these problems are seldom evident or available, especially in com-

bat. We have had to live with them from the beginning of fighter aviation, and our overall effectiveness in weapons delivery has certainly suffered because of them.

Have you ever wished that you could give a rocket a few corrections *after* launch to compensate for initial errors or corkscrewing? Wouldn't you like to be able to see your bomb during its fall and steer it into the target? If your answers to these questions are affirmative, you should be happy to know that in a very short time this is exactly what you will be doing. The new weapon that will permit us to equalize all but gross errors on launch is Bullpup (GAM-83).

Bullpup is a rocket boosted, pilot guided, air to surface bomb. In actual employment, the pilot fires the missile, the rocket motor boosts it to high supersonic velocity, and the pilot steers it to the target. The exact means by which he does this is classified, but in essence this is how it is employed. The boost of the rocket motor plus the guidance time available, permits accuracy heretofore impossible. As you probably suspect, this will permit you to launch Bullpup and recover above the effective range of most ground fire. To give you some insight without divulging classified information; under certain conditions, the maximum slant range for launching Bullpup is limited only by the service ceiling of our present aircraft!

It is not my intention to depict Bullpup as the panacea of fighter weapons; for certainly it is not. I merely intend to present some information on the progress being made in this field. Bullpup will be only as effective as the pilot delivering it. This is nothing new to fighter pilots, and it will be a very challenging and competitive weapon system. Effective Bullpup delivery is dependent upon pilot proficiency and technique. From all information available to date it should definitely provide an overall increase in our effectiveness.

There has been some cause for concern and degradation because Bullpup is not an all-weather weapon system. It was never intended as such, nor is such a weapon system available today within the "present state of the art." Bullpup, as with all present conventional weapons, requires visual acquisition of the target. Its increased effectiveness is derived through the capability of extreme accuracy and subsequently fewer sorties to destroy any given target.

As was the case with Sidewinder, Bullpup was developed for the U. S. Navy. The Martin Company, under contract from the Navy, conducted a study and developed Bullpup to improve the effectiveness of fighter weapons delivery. The U.S. Air Force subsequently purchased Bullpup and today it is joining TAC's arsenal. To alleviate unnecessary anticipation and concern you should know that it will be a little while before pilot training can begin.

The Training Research and Development Section has been preparing for Bullpup for quite some time. Our first Bullpup project will begin in November 1959, to evaluate certain aspects of the weapon system. Following this, we will conduct a project to determine pilot training, techniques and procedures. Naturally, we are as anxious as everyone else to see an early operational date for this weapon system. The pilot training program can however, make or break Bullpup. For this reason we must insist upon c o m p l e t e investigation, evaluation and by no means last - *complete support*!

To further emphasize the importance of proper pilot training, we cannot absorb the number of missiles required or the expense involved to allow indescriminate firings until a pilot achieves combat readiness in this weapon system. All training must be well directed and controlled.

Bullpup was developed for the fighter pilot. It offers nothing but advantages over present weapons to do the same job. Effective delivery will require pilot know-how and technique. Treat Bullpup as such, no more, and you will increase your effectiveness as a tactical fighter pilot because of it. ►

MK 106 MOD 0

By: Captain Gerald J. Hogemiller
TR&D Section

A few notes about one of the new training items entering the inventory. MK 106 Mod 0 is in limited quantity at the present time (supplied by San Antonio Air Material Area). The Navy developed and flight tested this shape for use as a retarded training item. To insure an immediate training device in the field, the MK 106 was adopted as an interim measure before the Air Force Standard BDU-2/B becomes available. Components making up MK 106 are the shape itself, M 173-A4 fuze (modified napalm fuze) supplied by Sacramento Air Material Area and Mk 4 Mod 3 signal. (See Figure 1). This training item comes without a lug so the MN-1A is required as a dispenser. Simple local modification of putting a retaining hook above the fuze will also provide usage with the MN-1 dispenser.

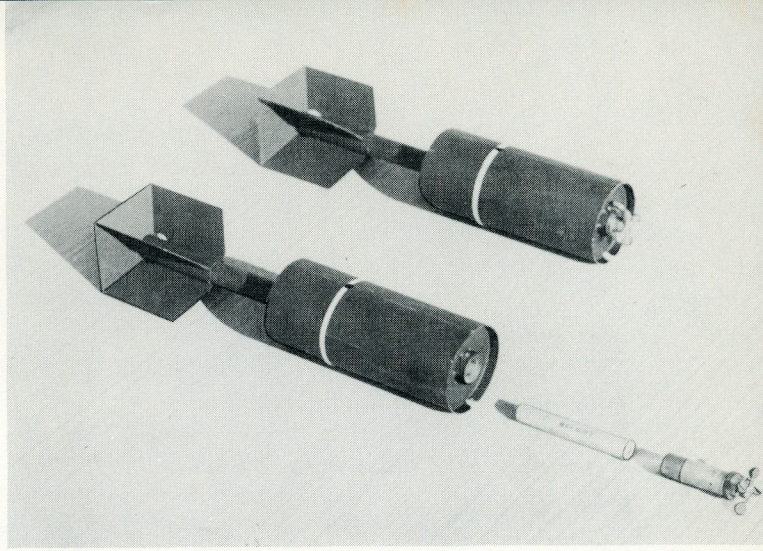


Figure 1

After a considerable number of MK 106 drops were completed, a spotting reliability of 60% was realized. After checking with Air Development Squadron Five, China Lake, California, our reliability was also verified by their recorded results. The problem is basically caused by the M 173-A4 fuze. On the ceiling of the container a hook must be positioned so as to extract an arming wire from the fuze as each bomb is ejected. As a result, the arming vanes upon entering the relative wind after ejection sometimes rotate toward the face of the fuze instead of the armed position. Explosive ordinance demolition personnel have recovered MK 106 bombs that have not spotted and found the arming vanes frozen against the fuze base.

An added inconvenience results from the fact that the ejection racks must be positioned to the aft position when ejecting MK 106 with fuzes. Eight (8) manhours are required to shift rack when changing from MK 76 to MK 106.

To simplify and improve MK 106 spotting, a plug was devised to operate on the same principle as MK 76 firing pin. This plug eliminates the arming wires and is made out of standard tow bar with a MK 76 firing pin seated at one end (Figure 2, 3, and 4). The plug is free to slide so that upon impact, the firing pin makes contact with the signal; this increased our spotting reliability to 85%. An

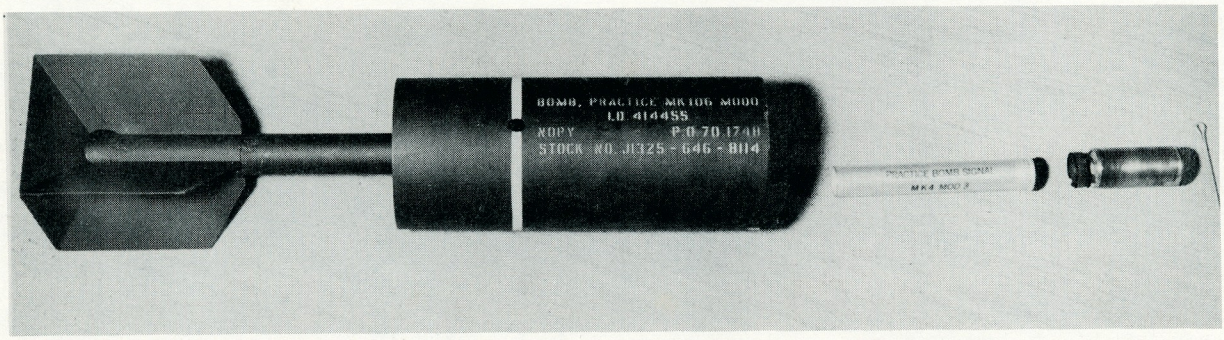


Figure 2

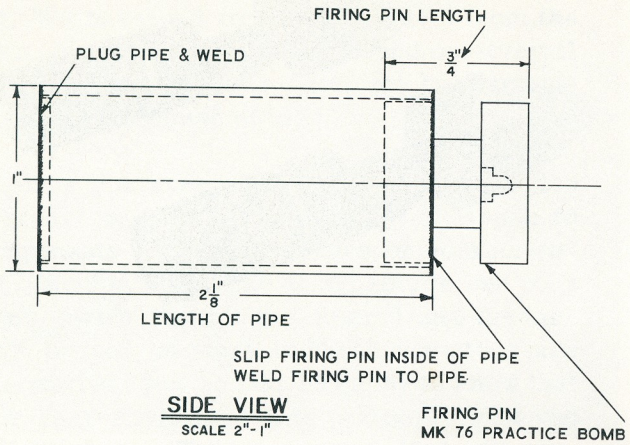


Figure 3

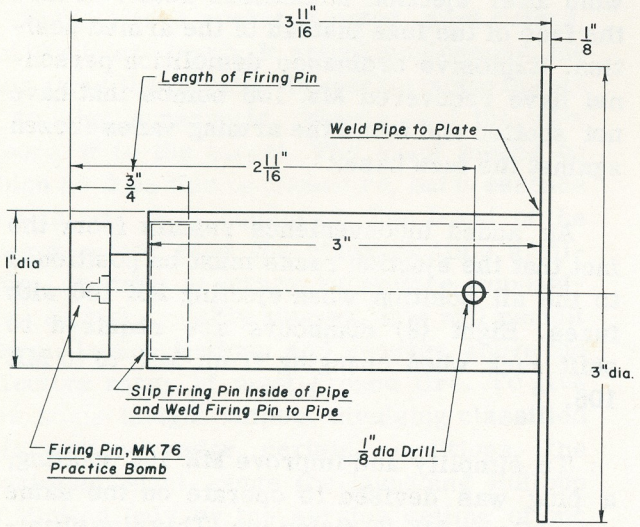


Figure 4

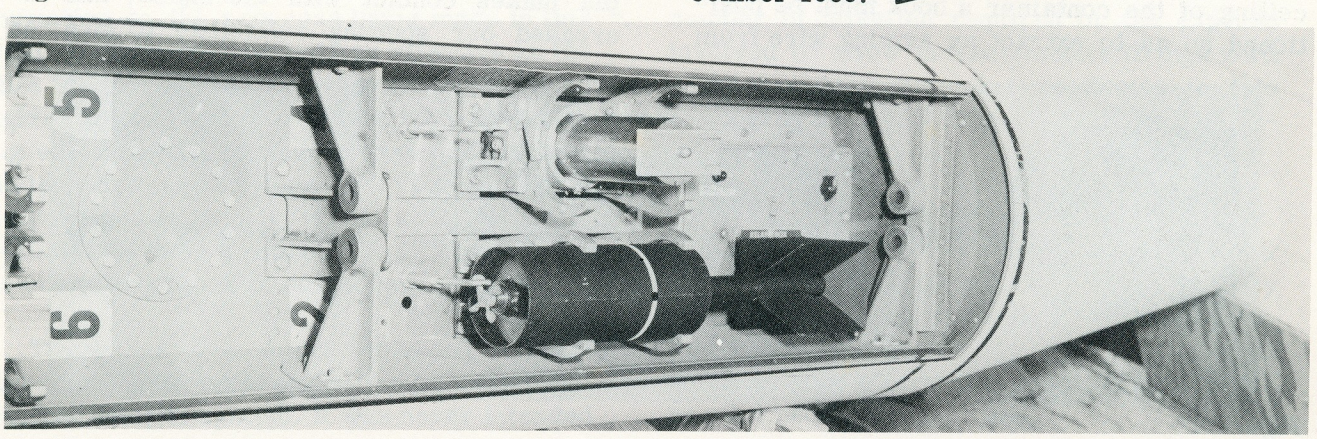
Figure 5

improvement of extending the plug 1/2 inch from the nose of the bomb, and welding a circular area three inches in diameter to the face of the plug is contemplated to improve the device already in use, providing a retarded and laydown spotting reliability. The plug in its present form can only be used on retarded drops.

An important time saver is also accomplished by using plugs instead of fuzes. Because the fuze extends approximately two (2) inches from the bomb, the ejection racks must be moved to an aft position to allow door clearance. When plugs are used, only the pad shoes and clamp inserts need be removed to convert to the MK 106 and ejection racks can be used in the forward position.

If fuzes are available and the MN-1 dispenser is not modified, it is recommended that the kick spin method of ejection be adopted (see figure 5). Using this method of arming the fuze, a reliability of 85% has been achieved. To insure proper rotation, a guide arm is located to kick the arming vane to the armed position upon ejection. This method of arming eliminates the arming wires because the guide arm will not allow the vane to turn. When the arm is positioned properly it will make contact, rotating the vane to the armed position as the bomb leaves the container.

Ballistic repeatability of this training device is excellent and an interim classified report on retarded and laydown tactics will be published and available in the field by 1 December 1959.



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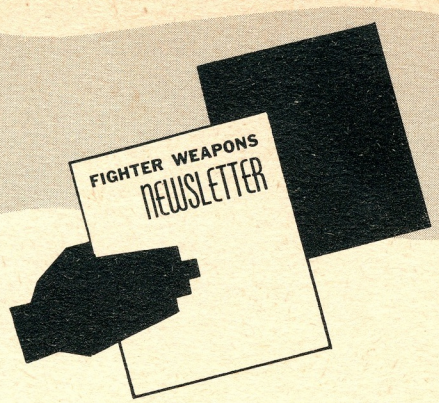

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